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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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[1] Withdrawn for publication elsewhere.

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THIRTY-FIRST ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Baltimore, Maryland, December 26 and 27, 1918

The thirty-first annual meeting of the American Association of Economic Entomologists will be held in Room 9, Gilman Hall, Johns Hopkins University, Baltimore, Md., on December 26 and 27, 1918.

Sessions will open at 10 a. m., Thursday, December 26. The annual reports and reports of committees will be presented, followed by the annual address of the President. The meeting of the general association will be continued at 1.30 p. m. On Friday a joint session will be held with the section on Horticultural Inspection, and a program has been arranged for Friday afternoon. If more time is necessary, the session will be continued on Friday evening.

Sectional Meetings

The meeting of the section on Apiculture will be held at 8 p. m., Thursday, December 26. The section on Horticultural Inspection will meet with the regular association in joint session, Friday morning.

Hotel Headquarters

Hotel headquarters for this association will be at the Southern Hotel, where rates of $3 per day and upward have been secured. Members are urgently requested to secure reservations of rooms in advance, and, if hotel facilities are not available, they should communicate with Miss L. M. Bollman, Librarian of the Johns Hopkins University, Baltimore, Md., who will arrange for rooms in private families. Miss Bollman has been authorized to act for the American Association for the Advancement of Science in this matter, and members desiring accommodations should state clearly whether they desire a room with board, room without board, or board only, the dates they expect to occupy room and the maximum price they wish to pay. Prompt attention to this matter will add materially to the success of the meeting.

Railroad Rates

Information concerning railroad rates to the meeting should be secured direct from Dr. L. O. Howard, Permanent Secretary, Smithsonian Institution, Washington, D. C.

Official Buttons

Official buttons for members of the association will be furnished to all those who have paid their dues for 1918. Applications for buttons should be made to the secretary at the time of the meeting.

Membership

Application blanks for membership can be secured from the secretary, or from members of the committee on membership, and all applications should be made out, properly endorsed, and filed with the membership committee on or before December 26.

Program

Thursday, December 26, 1918, 10.00 a. m.

Report of the Secretary.
Report of the executive committee, by President E. D. Ball.
Report of the employment bureau, by W. E. Hines, Auburn, Ala.
Report of the committee on nomenclature, by W. E. Britton, New Haven, Conn.
Report of the committee on entomological investigations, by W. J. Schoene, Blacksburg, Va.
Report of the committee on index of economic entomology, by E. P. Felt, Albany, N. Y.
Report of the committee on war service, by S. A. Forbes, Urbana, Ill.
Report of the committee on proposed amendment to the Constitution, by E. P. Felt, Albany, N. Y.
Appointment of committees.
Miscellaneous business.
New business.
Annual address of the President, E. D. Ball, Ames, Iowa.
"Economic Entomology—Its Foundation and Future."

Reading of Papers

"Practical Operation of Submergence as a Method of Controlling the Sprinkling Sewage Filter Fly," by Thomas J. Headlee, New Brunswick, N. J. (15 minutes.) Lantern.

"The Dispersion of Flies by Flight," by F. C. Bishopp and E. W. Laake, Dallas, Tex. (15 minutes.)

Results of experiments to determine the distance flies will travel. House flies and blow flies have been found to fly much farther than previously reported.

"The Control of the Body Louse on Clothes by Fumigation Methods," by G. H. Lamson, Jr., Storrs, Conn. (5 minutes.)

"Notes on *Phlebotomus sp.* Attacking Man," by D. C. Parman, Uvalde, Tex. (10 minutes.)

Seasonal occurrence, means of attack and habits with suggestion of transmission of disease.

"The Occurrence of *Drosophila* larvæ and puparia in bottled milk," by William A. Riley, St. Paul, Minn. (10 minutes.) Lantern.

"Some new practical Phases of the Entomology of Disease, Hygiene and Sanitation Developed by the War," by W. Dwight Pierce, Washington, D. C. (15 minutes.)

This paper will discuss new developments in the house fly, mosquito and cootie problems especially.

Adjournment.

Program

Thursday, December 26, 1918, 1.30 p. m.

Discussion of the Presidential Address.

Reading of Papers

"Biological Notes on Some Flatheaded Bark Borers of the Genus *Melanophila*," by H. E. Burke, Los Gatos, Calif. (10 minutes.)

"The Oak Twig Girdler (*Agrilus arcuatus* and var. *torquatus*)," by A. G. Ruggles, St. Paul, Minn. (10 minutes.) Lantern.

This insect is responsible for the destruction of 90 per cent of the dying oaks of the red group, and is doing a great amount of damage in Minnesota.

"On the Absence of Insect Pests in Certain Localities and on Certain Plants," by T. D. A. Cockerell, Boulder, Col. (5 minutes.)

"The Life-Cycle of *Lachnosterna lanceolata* Say.," by Wm. P. Hayes, Manhattan, Kan. (15 minutes.)

"Notes on Three Little Known Clover Pests," by Glenn W. Herrick and J. D. Detwiler. (8 minutes.)

"The Ohio Wheat Survey," by H. A. Gossard, Wooster, Ohio, and H. T. Parks, Columbus, Ohio. (15 minutes.)

Review of work for two seasons locating areas infested by various wheat pests and value of work in determining date for seeding and what cultural advice is needed.

"*Eleodes opaca* Say., An Important Enemy of Wheat in the Great Plains Area," by J. W. McColloch, Manhattan, Kan. (12 minutes.)

Life economy, economic importance, enemies, and some suggestions for its control.

"A Much Neglected Factor in Natural Control of Grain Aphis Epidemics—*Hippodamia convergens* Guer.," by A. C. Burrill, Pullman, Wash. (5 minutes.)

This paper will give some idea of the number and wide distribution of lady beetle caches, history of their use in the Northwest, some figures on comparative costs of control measures in favor of using beetles.

"Nineteen Hundred and Eighteen (1918) Outbreak and Control of *Melanoplus atlanis*," by E. G. Kelly, Manhattan, Kan. (15 minutes.)

Beginning of the outbreak in 1917—Discing for control. Campaign for poisoning in spring 1918—followed by second campaign for late seeding of wheat and poisoning.

"Experiments with Poison Bait against Grasshoppers," by D. A. Ricker, W. Lafayette, Ind. (10 minutes.)

Results obtained from a series of experiments with several poisons and a number of baits alone and in combination. Also comparison of results with complete meteorological data during the period.

"Reducing the Cost of Poison Baits," by J. J. Davis, Lafayette, Ind. (7 minutes.)

A short note summarizing results from all over the country as to the value of crude arsenious oxide.

"Methods of Obtaining Data from Field Experiments," by W. P. Flint, C. F. Turner and J. J. Davis, W. Lafayette, Ind. (10 minutes.)

Comparative methods for making insect counts with special reference to Hessian fly.

"Value of Shuck Covering in Conserving Corn in the Extreme South," "*The French Bark Thiers* and her cargo of Australian Wheat," by E. A. Back, Washington, D. C. (10 minutes.)

"Insects Affecting Wheat Flour and Wheat Flour Substitutes," by Royal N. Chapman, Minneapolis, Minn. (15 minutes.)

The war-time emergency—the relative susceptibility of various cereals to insect attack—methods of control, in mills, for small consumers, and for large consumers.

Adjournment.

Program

Friday, December 27, 1.30 p. m.

Reading of Papers

"The Morphology, Behavior and Susceptibility of the Eggs of Three Imported Apple Plant Lice," by Alvah Peterson, New Brunswick, N. J. (15 minutes.) Lantern.

Facts pertaining to the structure and behavior of the egg coverings during the dormant and hatching periods, and to the progressive susceptibility of the eggs during the early spring to common contact insecticides and other chemicals. Variations in percentage of moisture and degrees of temperature also influenced by percentage of hatch.

"Recent Developments in Fumigation with Liquid Hydrocyanic-acid," by R. S. Woglum, Alhambra, Calif. (15 minutes.)

Results of field observations and experiments in dosage and gas distribution.

"High Temperature Fumigation and Methods of Estimating Radiation Required," by W. H. Goodwin, New Brunswick, N. J. (10 minutes.)

"Kerosene Emulsion *versus* Nicotine Solution for Combatting the Potato Aphid," by W. E. Britton and M. P. Zappe, New Haven, Conn. (10 minutes.)

Serious outbreak of the insect caused local scarcity of nicotine solution. It was demonstrated that the materials for making kerosene emulsion could be obtained at about half the cost.

"The Potato Leafhopper (*Empoasca mali*) and the Leaf Burn It Causes," by E. D. Ball, Ames, Iowa. (15 minutes.) Lantern.

A widespread and destructive outbreak of marginal burning of potato leaves was found to be caused by this leaf-hopper.

"Some Notes on *Phorbia fusciceps* as a Bean Pest," by Ira M. Hawley, Ithaca, N. Y. (10 minutes.) Lantern.

Notes on life history, injury and prevention of damage from the insect.

"*Phorbia fusciceps* Zett., Biological Notes, Injury to Lima Beans," by David E. Fink, Riverton, N. J. (10 minutes.)

"Parasite Introduction as a Means of Saving Sugar," by T. E. Holloway, Audubon Park, New Orleans, La. (15 minutes.)

A report of progress on the introduction of tachinid parasites of the sugar-cane moth borer (*Diatræa saccharalis*).

"Limitations in Insect Suppression," by Walter C. O'Kane, Durham, N. H. (15 minutes.)

"Entomological Needs," by J. J. Davis, W. Lafayette, Ind. (15 minutes.)

A résumé based on questionnaires and personal experience on points of improvement in bulletins and other entomological information for county agents and farmers, and the needs of agricultural students.

"Coöperative Extension Entomology in Texas," by A. H. Hollinger, College Station, Tex. (15 minutes.)

Results obtained under the Emergency Appropriation, and scope and plans for the season of 1918–1919.

"Combining Dormant and First Summer Spray in Apple Orchards," by T. J. Talbert, Columbia, Mo. (10 minutes.)

The results obtained in controlling San José scale by applying the concentrated lime sulphur solution (1–7) just before apple trees bloom but after the cluster buds have separated.

"Control of the Chrysanthemum Gall Midge with Nicotine Sulphate,—With Notes on Life Cycle," by T. L. Guyton, Harrisburg, Pa. (5 minutes.) Lantern.

"Economic Aspects of the Syrphidæ of Maine," by C. L. Metcalf, Columbus, Ohio. (5 minutes.)

A brief discussion of the unusual richness in number of species of the *aphidophagous* genera as compared with other states; and other economic phases.

Final Business

Report of committee on auditing.

Report of committee on resolutions.

Report of committee on membership.

Report of other committees.

Nomination of Journal officers by advisory committee.

Report of committee on nominations.

Election of officers.

Miscellaneous business.

Fixing the time and place of next meeting.

Final adjournment.

E. D. Ball, *President*,
Ames, Iowa.

A. F. Burgess, *Secretary*,
Melrose Highlands, Mass.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

(Organized 1889, Incorporated December 29, 1913)

OFFICERS, 1918

President
E. D. Ball, Madison, Wisconsin.

First Vice-President
W. C. O'Kane, Durham, New Hampshire.

Second Vice-President (Pacific Slope Branch)
George P. Weldon, Sacramento, California.

Third Vice-President (Horticultural Inspection)
E. C. Cotton, Columbus, Ohio.

Fourth Vice-President (Apiculture)
Franklin Sherman, Jr., Raleigh, North Carolina.

Secretary
A. F. Burgess, Melrose Highlands, Massachusetts.

Pacific Slope Branch

Secretary
E. O. Essig, Ventura, California.

Section of Horticultural Inspection

Secretary
J. G. Sanders, Harrisburg, Pennsylvania.

Section of Apiculture

Secretary
G. M. Bentley, Knoxville, Tennessee.

Standing Committees

Committee on Nomenclature

W. E. Britton, Chairman, New Haven, Conn. Term expires 1918.
Glenn W. Herrick, Ithaca, N. Y. Term expires 1919.
Edith M. Patch, Orono, Me. Term expires 1920.

Committee on Entomological Investigations

W. J. Schoene, Chairman, Blacksburg, Va. Term expires 1919.
H. T. Fernald, Amherst, Mass. Term expires 1918.
George A. Dean, Manhattan, Kan. Term expires 1920.

Committee on Membership

J. J. Davis, West Lafayette, Ind., Chairman. Term expires 1918.
W. E. Britton, New Haven, Conn. Term expires 1919.
T. J. Headlee, New Brunswick, N. J. Term expires 1920.

Councillors for the American Association for the Advancement of Science

H. A. Gossard, Wooster, Ohio.
R. A. Cooley, Bozeman, Mont.

Entomologists' Employment Bureau

W. E. Hinds, Director, Auburn, Ala.

LIST OF MEETINGS AND PAST OFFICERS

First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; First Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 17–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wis., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President, W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty-eighth Annual Meeting.)

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27–30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President, W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-ninth Annual Meeting, New York, N. Y., Dec. 28–30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

Thirtieth Annual Meeting, Pittsburgh, Pa., Dec. 31, 1917–Jan. 2, 1918. President, R. A. Cooley; First Vice-President, W. E. Hinds; Second Vice-President, A. W. Morrill; Third Vice-President, G. M. Bentley; Fourth Vice-President, B. N. Gates; Secretary, A. F. Burgess.

LIST OF MEMBERS

ACTIVE MEMBERS

Ainslie, C. N., 5009 Orleans Ave., Sioux City, Iowa.
Ainslie, George G., R. R. 9, Knoxville, Tenn.
Aldrich, J. M., U. S. Bureau of Entomology, West Lafayette, Ind.
Back, E. A., U. S. Bureau of Entomology, Washington, D. C.
Baker, C. F., Singapore, Straits Settlements.
Ball, E. D., State Capitol, Madison, Wis.
Banks, C. S., College of Agriculture, Los Banos, P. I.
Banks, Nathan, Museum of Comparative Zoölogy, Cambridge, Mass.
Barber, H. S., U. S. Bureau of Entomology, Washington, D. C.
Becker, G. G., Agricultural Experiment Station, Fayetteville, Ark.
Bentley, G. M., University of Tennessee, Knoxville, Tenn.
Berger, E. W., University of Florida, Gainesville, Fla.
Bethune, C. J. S., Guelph, Ontario, Canada.
Bishopp, F. C., U. S. Bureau of Entomology, Dallas, Texas.
Britton, W. E., Agricultural Experiment Station, New Haven, Conn.
Brooks, F. E., U. S. Bureau of Entomology, French Creek, W. Va.
Brues, C. T., Bussey Institution, Forest Hills, Boston, Mass.
Bruner, Lawrence, Agricultural Experiment Station, Lincoln, Neb.
Burgess, A. F., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Burke, H. E., Los Gatos, Cal.
Busck, August, U. S. National Museum, Washington, D. C.
Caesar, Lawson, Ontario Agricultural College, Guelph, Canada.
Caffrey, D. J., U. S. Bureau of Entomology, Hagerstown, Md.
Caudell, A. N., U. S. National Museum, Washington, D. C.
Chittenden, F. H., U. S. Bureau of Entomology, Washington, D. C.
Coad, B. R., U. S. Bureau of Entomology, Tallulah, La.
Cockerell, T. D. A., Boulder, Colo.
Collins, C. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Comstock, J. H., Cornell University, Ithaca, N. Y.
Conradi, A. F., Clemson College, S. C.
Cook, Mel. T., Agricultural Experiment Station, New Brunswick, N. J.
Cooley, R. A., Agricultural Experiment Station, Bozeman, Mont.
Cory, E. N., Agricultural Experiment Station, College Park, Md.
Cotton, E. C., Department of Agriculture, Columbus, Ohio.
Crawford, J. C., U. S. National Museum, Washington, D. C.
Creel, C. W., U. S. Bureau of Entomology, Forest Grove, Oregon.
Criddle, Norman, Treesbank, Manitoba, Canada.
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Crossman, S. S., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Davis, J. J., U. S. Bureau of Entomology, West Lafayette, Ind.
Dean, George A., Agricultural Experiment Station, Manhattan, Kan.
Ehrhorn, E. M., Honolulu, H. T.
Essig, E. O., Ventura, Cal.
Felt, E. P., State Museum, Albany, N. Y.
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Fernald, H. T., Agricultural College, Amherst, Mass.
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Forbes, S. A., University of Illinois, Urbana, Ill.
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Fullaway, D. T., Agricultural Experiment Station, Honolulu, H. T.
Fulton, B. B., Agricultural Experiment Station, Geneva, N. Y.
Gahan, A. B., Berwyn, Md.
Garman, H., Agricultural Experiment Station, Lexington, Ky.
Gates, B. N., Agricultural Experiment Station, Amherst, Mass.
Gibson, Arthur, Entomological Branch, Ottawa, Canada.
Gillette, C. P., Agricultural Experiment Station, Fort Collins, Colo.
Goodwin, W. H., care Economic Zoölogist, Harrisburg, Pa.
Gossard, H. A., Agricultural Experiment Station, Wooster, Ohio.
Harned, R. W., Agricultural College, Miss.
Hart, C. A., Illinois State Laboratory of Natural History, Urbana, Ill.
Hartzell, F. Z., Agricultural Experiment Station, Fredonia, N. Y.
Headlee, T. J., Agricultural Experiment Station, New Brunswick, N. J.
Herms, W. B., University of California, Berkeley, Cal.
Herrick, Glenn W., Cornell University, Ithaca, N. Y.
Hewitt, C. Gordon, Dominion Entomologist, Ottawa, Canada.
High, M. M., U. S. Bureau of Entomology, Kingsville, Texas.
Hinds, W. E., Agricultural Experiment Station, Auburn, Ala.
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Holland, W. J., Carnegie Museum, Pittsburgh, Pa.
Holloway, T. E., U. S. Bureau of Entomology, Audubon Park, La.
Hooker, W. A., States Relation Service, Washington, D. C.
Hopkins, A. D., U. S. Bureau of Entomology, Washington, D. C.
Houghton, C. O., Agricultural Experiment Station, Newark, Del.
Houser, J. S., Agricultural Experiment Station, Wooster, Ohio.
Howard, C. W., Christian College, Canton, China.
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Hungerford, H. B., University of Kansas, Lawrence, Kan.
Hunter, S. J., University of Kansas, Lawrence, Kan.
Hunter, W. D., U. S. Bureau of Entomology, Washington, D. C.
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Kotinsky, J., U. S. Bureau of Entomology, Washington, D. C.
Lochhead, Wm., Macdonald College, Canada.
MacGillivray, A. D., University of Illinois, Urbana, Ill.
Marlatt, C. L., U. S. Bureau of Entomology, Washington, D. C.
Marsh, H. O., U. S. Bureau of Entomology, Rocky Ford, Col.
Matheson, Robert, Cornell University, Ithaca, N. Y.
McColloch, J. W., Agricultural Experiment Station, Manhattan, Kan.
McConnell, W. R., U. S. Bureau of Entomology, Carlisle, Pa.

McGregor, E. A., U. S. Bureau of Entomology, El Centro, Cal.
Merrill, J. H., Agricultural Experiment Station, Manhattan, Kan.
Metcalf, C. L., Ohio State University, Columbus, Ohio.
Metcalf, Z. P., Agricultural Experiment Station, West Raleigh, N. C.
Moore, Wm., University Farm, St. Paul, Minn.
Morgan, A. C., U. S. Bureau of Entomology, Clarksville, Tenn.
Morgan, H. A., Agricultural Experiment Station, Knoxville, Tenn.
Morrill, A. W., Phoenix, Ariz.
Newell, Wilmon, State Plant Commission, Gainesville, Fla.
O'Kane, W. C., Agricultural Experiment Station, Durham, N. H.
Osborn, Herbert, Ohio State University, Columbus, Ohio.
Paddock, F. B., College Station, Texas.
Parker, J. R., Agricultural Experiment Station, Bozeman, Mont.
Parrott, P. J., Agricultural Experiment Station, Geneva, N. Y.
Patch, Edith M., Agricultural Experiment Station, Orono, Me.
Peairs, L. M., Agricultural Experiment Station, Morgantown, W. Va.
Perkins, R. C. L., Park Hill House, Paignton, England.
Pettit, Morley, Georgetown, Ontario, Canada.
Pettit, R. H., Agricultural Experiment Station, East Lansing, Mich.
Phillips, E. F., U. S. Bureau of Entomology, Washington, D. C.
Phillips, W. J., U. S. Bureau of Entomology, Charlottesville, Va.
Pierce, W. D., U. S. Bureau of Entomology, Washington, D. C.
Quaintance, A. L., U. S. Bureau of Entomology, Washington, D. C.
Quayle, H. J., University of California, Berkeley, Cal.
Reeves, George I., U. S. Bureau of Entomology, Salt Lake City, Utah.
Riley, W. A., Cornell University, Ithaca, N. Y.
Ruggles, A. G., University Farm, St. Paul, Minn.
Rumsey, W. E., Agricultural Experiment Station, Morgantown, W. Va.
Sanders, G. E., Entomological Branch, Annapolis Royal, N. S.
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Schoene, W. J., Agricultural Experiment Station, Blacksburg, Va.
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Pospielow, Dr. Walremar, Station Entomologique, Rue de Boulevard, No. 9, Kiew, Russia.
Reed, Charles S., Mendoza, Argentine Republic, South America.
Ritzema Bos, Dr. J., Agricultural College, Wageningen, Netherlands.
Rosenfeld, A. H., Estacion Experimental Agricola, Tucuman, Argentina.
Sajo, Prof. Karl, Gödöllö-Veresegyház, Hungary.

Schoyen, Prof. W. M., Zoölogical Museum, Christiania, Norway.
Severin, Prof. G., Curator Natural History Museum, Brussels, Belgium.
Shipley, Prof. Arthur E., Christ's College, Cambridge, England.
Silvestri, Dr. F., R. Scuola Superiore di Agricoltura, Portici, Italy.
Theobald, Frederick V., Wye Court, Wye, Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tryon, H., Queensland Museum, Brisbane, Queensland, Australia.
Urich, F. W., Victoria Institute, Port of Spain, Trinidad, West Indies.
Vermorel, V., Station Viticole, Villefranche, Rhone, France.

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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 11 FEBRUARY, 1918 No. 1

Proceedings of the Thirtieth Annual Meeting of the American Association of Economic Entomologists

The thirtieth annual meeting of the American Association of Economic Entomologists was held in Assembly Hall, Carnegie Museum, Pittsburgh, Pa., December 31, 1917, to January 2, 1918, inclusive.

The first session was held at 10.00 a. m., December 31, when the annual reports were submitted and the address of the President was given.

The meeting of the Section on Apiculture was held at 8.00 p. m., December 31.

The meeting of the Section on Horticultural Inspection was held at 1.30 p. m. and at 8.00 p. m., January 1, at Carnegie Museum.

The business proceedings of the Association are given as Part I of this report and the addresses, papers and discussion appear as Part II.

The proceedings of the sections were prepared by the sectional secretaries and are published as a part of this report.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President R. A. Cooley at 10.00 a. m., Monday, December 31, 1917. About 100 members and visitors attended the sessions. The following members were present:

Ainslie, C. N., Sioux City, Iowa.
Ainslie, George G., Knoxville, Tenn.
Backus, H. E., Northeast, Pa.
Aldrich, J. M., West Lafayette, Ind.
Ball, E. D., Madison, Wis.
Barnes, P. T., Harrisburg, Pa.
Bentley, G. M., Knoxville, Tenn.
Bilsing, S. W., College Station, Texas.
Bishopp, F. C., Dallas, Texas.
Burgess, A. F., Melrose Highlands, Mass.
Cooley, R. A., Bozeman, Mont.
Cotton, E. C., Columbus, Ohio.
Creel, C. W., Forest Grove, Ore.
Davis, J. J., West Lafayette, Ind.

Dean, George A., Manhattan, Kan.
Dietz, H. F., Washington, D. C.
Eckert, J. E., Raleigh, N. C.
Eddy, M. W., State College, Pa.
Ewing, H. E., Ames, Iowa.
Felt, E. P., Albany, N. Y.
Fenton, F. A., Columbus, Ohio.
Flint, W. P., Springfield, Ill.
Forbes, S. A., Urbana, Ill.
Fulton, B. B., Geneva, N. Y.
Garman, Philip, College Park, Md.
Gentner, L. G., Madison, Wis.
Glenn, P. A., Urbana, Ill.
Goodwin, W. H., Harrisburg, Pa.
Gossard, H. A., Wooster, Ohio.
Guyton, T. L., Wooster, Ohio.
Hadley, C. H., State College, Pa.
Hartzell, F. Z., Fredonia, N. Y.
Headlee, T. J., New Brunswick, N. J.
Hine, J. S., Columbus, Ohio.
Holland, W. J., Pittsburgh, Pa.
Houser, J. S., Wooster, Ohio.
Howard, L. O., Washington, D. C.
Howard, N. F., Madison, Wis.
Hunter, S. J., Lawrence, Kan.
Jones, T. H., Baton Rouge, La.
Kellogg, V. L., Stanford University, Cal.
King, J. L., Harrisburg, Pa.
Kirk, H. B., Harrisburg, Pa.
Kisliuk, Max, Clarksville, Tenn.
Knull, J. N., Harrisburg, Pa.
Lovett, A. L., Corvallis, Ore.
McConnell, W. R., Carlisle, Pa.
Metcalf, C. L., Columbus, Ohio.
Morrill, A. W., Phoenix, Ariz.
Morrison, Harold, Washington, D. C.
O'Kane, W. C., Durham, N. H.
Osborn, Herbert, Columbus, Ohio.
Packard, C. M., Martinez, Cal.
Parker, R. R., Bozeman, Mont.
Peairs, L. M., Morgantown, W. Va.
Peterson, Alvah, New Brunswick, N. J.
Pierson, C. J., College Park, Md.
Primm, J. K., Philadelphia, Pa.
Rea, G. H., Harrisburg, Pa.
Reese, C. A., Charleston, W. Va.
Ruggles, A. G., St. Paul, Minn.
Rumsey, W. E., Morgantown, W. Va.
Sams, C. L., Raleigh, N. C.
Sanders, J. G., Harrisburg, Pa.
Sasscer, E. R., Washington, D. C.
Satterthwait, A. F., Lafayette, Ind.
Schoene, W. J., Blacksburg, Va.
Shaw, N. E., Columbus, Ohio.
Sherman, Franklin, Jr., Raleigh, N. C.
Stear, Jacob R., Wooster, Ohio.
Stearns, L. A., Alma, Mich.
Swenk, M. H., Lincoln, Neb.
Trimble, F. M., Primos, Pa.
Webster, R. L., Ames, Iowa.
Weigel, C. A., Columbus, Ohio.
Whelan, Don B., East Lansing, Mich.
Woglum, R. S., Alhambra, Cal.

President R. A. Cooley: You will please come to order. The first business on the program is the report of the Secretary.

REPORT OF THE SECRETARY

The total membership of the Association at the time of the last annual meeting was 466, divided as follows: active 134, associate 282, and foreign 50. At that meeting one associate member resigned and twelve were transferred to active membership. During the year one active and thirteen associate members have been dropped from the rolls, and two associate members have died.

The present membership totals 501, divided as follows: active 145, associate 306, and foreign 50. The net gain for the year has been 35 members.

On February 24, 1917, Mr. Francis Windle died at his home at West Chester, Pa. He had been a member of the Association for a number of years, had attended several of the meetings, and was greatly interested in entomology and natural history in all its branches.

In November, 1916, Mr. E. B. Reed, an associate member, died at Victoria, British Columbia. Mr. Reed had been for many years a member of this Association and was highly respected by all who knew him.

The Pacific Slope Branch of the Association held its annual meeting at Stanford University, California, April 5 and 6, 1917, 37 members and visitors being present. The meeting was very successful and the proceedings were published in full in the June number of the JOURNAL OF ECONOMIC ENTOMOLOGY.

In the last annual report the Secretary stated that the condition of the finances of the Association was such that the publication of the Index of American Economic Entomology could be undertaken if a reasonable number of advance subscriptions could be secured. At that meeting it was voted that the publication of the Index be placed in the hands of the editorial board of the JOURNAL OF ECONOMIC ENTOMOLOGY.

Owing to the rapid increase in the cost of publishing, it was deemed wise for the board to fix the subscription at a rate which would enable the work to be published without involving the Association financially. It was therefore decided that the Index be furnished to members of the Association, who subscribed before April 10, at the rate of $4.00 a copy, and that after that time the price would be fixed at $5.00 a copy for domestic subscriptions and $5.50 for subscriptions forwarded to foreign countries. The advanced subscriptions received were sufficient to pay a portion of the cost of publication, but it was necessary to transfer $500.00 from the treasury of the Association at the time the book was printed in order to pay cash for the publication. The financial statement shows that $200.00 of the amount borrowed has been returned to the Association treasury and a balance of $15.51 remains to the credit of the Index fund. Future sales should make it possible to pay back the $300.00 outstanding, and in time a small surplus may be accumulated to meet part of the expense of publishing a later volume, should the Association decide to continue this work.

THE JOURNAL OF ECONOMIC ENTOMOLOGY

The JOURNAL has had a reasonably successful year, although the increased cost of everything which goes to make up a publication has materially reduced the balance over that which was reported last year.

During 1917, the six issues have embraced 572 pages, which is approximately the same as the number published the year before.

The number of subscriptions have not changed materially from those received in 1916, but many of the collections have been very slow, this being particularly true on foreign orders.

The advertising in the JOURNAL is gradually decreasing,—hence the income from this source is not large at the present time.

Unless the number of subscriptions is very materially increased during the coming year, or the number of printed pages reduced, it will be necessary to increase the price of the publication if it is to be self-supporting.

In view of the fact that a considerable number of papers are published each year in the JOURNAL which are contributed by non-members of the Association, and that it is necessary, in some cases, to hold articles submitted by members for several months before they can be published, it is suggested that during the present emergency it might be well to publish only such papers as are presented by members.

ASSOCIATION STATEMENT

Balance in Treasury, December 20, 1916		$777.75
By amount received from dues, 1917		498.50
By amount received from interest in Melrose Savings Bank		6.10
By amount received from interest in Malden National Bank		9.87
To stenographic report 1916 meeting	$60.00	
Buttons, 1916 meeting	10.50	
Postage	52.20	

Printing programs, etc.	$45.85	
Telegraph and express	.56	
Miscellaneous supplies	1.08	
Transfer cases	5.60	
Drawing seal	10.00	
Pacific Slope Branch	9.80	
Committee on Entomological Investigations	22.76	
Transfer to Index Fund	300.00	
One $100 4% Liberty Bond	100.00	
Clerical work, Secretary's office	35.00	
One-half salary of Secretary	50.00	
	$703.35	
Balance, December 7, 1917	588.87	
	$1,292.22	$1,292.22

Balance deposited as follows:

Melrose Savings Bank	$157.42
Malden National Bank	431.45

JOURNAL STATEMENT

Balance in Treasury, December 21, 1916		$646.87
By amount received for subscriptions, advertising, etc., 1917		2,187.97
To stamps and stamped envelopes	$39.29	
Express	1.06	
Printing	2,128.83	
Halftones	172.28	
Miscellaneous supplies	14.00	
Insurance on JOURNALS in stock	18.75	
Clerical work, Editor's office	70.00	
Clerical work, Secretary's office	60.00	
Salary, Editor	100.00	
One-half salary of Secretary	50.00	
	$2,654.21	
Balance, December 7, 1917	189.27	
	$2,843.48	$2,843.48

Deposited in Malden National Bank $189.27

INDEX STATEMENT

By amount received from sale of Index		$928.50
By amount transferred from Association Treasury		300.00
To postage and express	$26.48	
Printing circulars	7.25	
Printing Index	1,105.06	
Clerical work and proof reading	57.20	
Insurance on stock on hand	17.00	
	$1,212.99	
Balance, December 7, 1917	15.51	
	$1,228.50	$1,228.50

Deposited in Malden National Bank $15.51

SUMMARY

Balance on Index Account	$15.51
Balance on Journal account	189.27
Balance on Association account	588.87
One 4% Liberty Bond	100.00
	$893.65

Deposited in Melrose Savings Bank $157.42
Deposited in Malden National Bank 636.23

Respectfully submitted,

A. F. BURGESS, *Secretary.*

On motion, the report was accepted and the financial part referred to the auditing committee.

PRESIDENT R. A. COOLEY: The next item on the program is the report of the executive committee. This committee has not held a meeting during the year, and there is therefore no business of importance to report. I will now call for the report of the employment bureau, which will be read by the secretary.

REPORT OF ENTOMOLOGISTS' EMPLOYMENT BUREAU FOR 1917

December 26, 1917.

The Entomologists' Employment Bureau seeks to interest and help in the most impartial and impersonal manner possible both employers and employees in the field of entomology. The policy of the Bureau under the present administration is simply to bring together candidates seeking positions in various phases of entomological work and those employers who are responsible for the recommendations or appointments to such positions. When information concerning a possible position comes to the attention of the Bureau, it has been the practice to furnish to the employer a list of several names of such men as appear from their enrollment blanks to be best fitted for the position in question and possibly available for the appointment. An abstract of the principle points given on the enrollment blank with the names of parties to whom the candidate refers for additional information is furnished the employer for each name. It is expected that the employer should then select and communicate with such candidates as he desires to investigate further. Notice is also sent to each candidate whose name has been thus used, advising him to get into communication with the employer and learn full details regarding the position and present complete and up-to-date information regarding his own qualifications for appointment.

During the calender year 1917, 12 new names have been enrolled in the Bureau. Seven former members have re-inrolled during the year. Six other men have received the total of 10 references offered by the Bureau for the enrollment fee of $2. These men have been notified but as yet we have received no reply from them. The total number of the roll at present is 65.

Information has come to the Bureau regarding 24 openings, and among these 4 men suggested by the Bureau have been definitely placed with several more from which we have not yet heard because of neglect on the part of the candidate, no doubt, and of recent notifications. Two hundred and eleven names have been suggested to these possible employers for their further consideration and selection

of such candidates as seem to be best fitted for the particular work desired. Nearly 500 letters have been sent out during the year.

Financial statement of the Bureau is presented herewith:

	Dr.	
Cash on hand January 1, 1917	$57.55	
To 19 enrollment fees at $2	38.00	
Total receipts		$95.55
	Cr.	
February 9, 400 blank forms and printed (voucher 1)	$1.96	
May 1, Stenographic work (voucher 2)	15.00	
December 26, to 425 envelopes (voucher 3)	2.25	
December 26, to stamps (voucher 4)	9.24	
December 26, Stenographic work (voucher 5)	20.00	
Total		48.45
Balance on hand December 26, 1917		$47.10

W. E. Hinds, *In Charge.*

On motion, the report was accepted and the financial part referred to the auditing committee.

President R. A. Cooley: I will now call for the report of the committee on nomenclature.

Secretary A. F. Burgess: Prof. Herbert Osborn, chairman of the committee, wished me to state that it was impossible for him to be present at this session on account of another engagement. He asked me to say that no names had been submitted to the committee for consideration during the past year, and that the committee had no formal report to make.

President R. A. Cooley: The next on the program is the report of the committee on entomological investigations.

Secretary A. F. Burgess: No report has been received from this committee other than the one that was mimeographed and sent to all the members of the Association early in December. I infer that the committee feels that this was the only report that it was necessary to make.

By vote of the Association, the report was adopted.

President R. A. Cooley: I will now call for the report of the committee on entomological work at the U. S. National Museum.

REPORT OF COMMITTEE ON NATIONAL MUSEUM

This committee appointed at our last annual meeting has been active the past year studying conditions in the U. S. National Museum for the purpose of offering means for promoting and providing for adequate development of the insect collections. Data on the existing conditions have been obtained with a view to determining practical means of assistance and coöperation which could be supported by this Association, as a whole or as individuals, in the development of the entomological work.

This committee therefore offer the following suggestions.

1. It is evident that the space allotted to the Division of Insects is insufficient for the proper handling of the great mass of material received for study and determination. The present crowded conditions materially decreases the efficiency of the staff.

2. The present staff is insufficient to handle the material received for determination and to remedy this difficulty the Division of Insects should be allotted much larger funds, not only for the enlargement of the staff of systematic workers but also for the purpose of purchasing valuable collections when they are obtainable only by purchase.

3. Entomologists studying certain groups are urged to furnish the National Museum with types or cotypes of species described by them as well as duplicate representatives of groups being worked up, and to coöperate with the Museum authorities in every possible way, thus enabling our National Museum to be truly national in scope and representative of the American continent.

4. Most of our serious introduced insect pests were not recognized until after they had become well established. The great importance of being able to obtain immediate determinations of unknown insects discovered in this country is evident to every entomologist who has followed the course of introduced species. We therefore believe that this institution should have a collection not only thoroughly representative of American insects, but an almost equally complete series of exotic species, particularly of the palearctic fauna, since commercial activities mean numerous introductions from other countries, and among these, as experience has shown in the past, there are bound to be some very destructive pests.

5. We suggest that our members employ every opportunity to impress persons in authority with the fact that the development of economic entomology in this country makes it imperative that the systematic work upon insects be developed to a corresponding degree, since correct identification is a fundamental to satisfactory control and to urge support for the Division of Insects of the U. S. National Museum. Although present war conditions make it difficult to secure increased funds, your committee feels that now, more than ever before, greater support should be given. Since the value of this work as a coördinate part of economic entomology is vital and since insect control is so essential in the great movement for increased food production, this expansion is of utmost importance.

Respectfully submitted,

John J. Davis,
R. L. Webster,
Herbert Osborn,
E. D. Ball,
E. P. Felt,
Committee.

By vote of the Association, the report was accepted and the recommendations adopted.

President R. A. Cooley: I will now appoint the committees.

Committee on Auditing: T. J. Headlee, A. G. Ruggles.

Committee on Resolutions: E. D. Ball, W. C. O'Kane, F. C. Bishopp.

Committee on Nominations: Herbert Osborn, W. A. Morrill, W. J. Schoene.

President R. A. Cooley: Is there any new business?

Mr. J. G. Sanders: I would like to present a proposed amendment to the constitution relative to membership. The draft which I have

here provides for replacing the classes of active and associate membership with three classes, namely: honorary fellows, fellows and members. As this matter must be referred to a committee for consideration, I would like to present it at this time so that the committee can be appointed and bring in their recommendations in order that action may be taken at the next annual meeting. I move that a committee of three be appointed for this purpose.

By a vote of the Association the President was instructed to appoint the committee.

President R. A. Cooley: If there is no further business, the President's address will now be given. I notice that one of our oldest past Presidents is present at the meeting, and I will therefore ask Dr. S. A. Forbes to preside.

Mr. S. A. Forbes: We will now have the annual address of the President.

At the conclusion of the address, Dr. Forbes stated that the discussion would be deferred until the afternoon session.

At the close of the session the following committee was appointed to consider the proposed amendment to the constitution: E. P. Felt, W. C. O'Kane, and J. G. Sanders.

At the afternoon session, Mr. Herbert Osborn stated that a matter had come up before Section F of the American Association concerning the bibliography of entomology. The following resolution had been offered in that section which he presented to the Association for consideration and action:

Resolved, That in the opinion of the American Association of Economic Entomologists, it is important that any plans formulated or encouraged by the American Association for the Advancement of Science looking toward the organization and advancement of national or international bibliographic projects, the existing international bibliographic undertaking for zoölogy, the Concilium Bibliographicum, Zurich, Switzerland, long approved by the American Association and in part supported by numerous grants from its funds, be kept definitely in mind and included in any plans for bibliographic work.

By vote of the Association the resolution was approved.

At the session held Tuesday morning, it was voted that the committee on resolutions be instructed to prepare an appropriate resolution relative to the attitude of this Association and the availability of its members for war service. It was voted that a committee of three be appointed by the President to bring these resolutions to the attention of the federal authorities. At the close of the session, the President appointed the following committee: S. A. Forbes, E. P. Felt, and W. C. O'Kane.

At the final session, Wednesday afternoon, January 2, the closing business of the Association was transacted.

President R. A. Cooley: I will now call for the report of the committee on auditing.

REPORT OF THE AUDITING COMMITTEE

We, the undersigned, your committee on audit, hereby certify that we have examined the bills and accounts of your secretary covering income and expenditures from the Association, the Journal and from the Index—also the accounts of the Employment Bureau—and that we believe the same to be correct.

Signed Thomas J. Headlee,
A. G. Ruggles,
Committee.

By vote of the Association, the report was accepted and adopted.

President R. A. Cooley: I will call next for the report of the committee on resolutions.

Mr. E. D. Ball: The resolution relative to war service was drafted by the committee with the assistance of Mr. Herbert Osborn and Mr. E. P. Felt.

REPORT OF THE COMMITTEE ON RESOLUTIONS

We, the members of the American Association of Economic Entomologists, wish to express by this resolution our deep desire to be of every possible service to the nation in the war. Whatever duty may fall to us we shall consider it an honor and a privilege to perform.

We are deeply conscious of the complex problems and difficulties that have fallen to those on whom the direction of the war must rest; and we wish further to express our appreciation of the extraordinary achievement already won in mastering these difficulties and in solving these problems.

As a loyal body of American citizens we are eager to assist in meeting such special problems as our technical knowledge and training may help to solve. It is our hope, therefore, to offer in fullest degree the technical services of our individual members. This we feel to be of great moment because of the vital bearing of expert entomological knowledge on certain serious phases of camp sanitation, especially in the prevention of the insect-borne diseases, including typhus and cholera, that have exacted severe toll in all wars, including the present struggle, and in the conservation of perishable supplies belonging to the army.

For this service it is our privilege to offer a body of men who have had a practical, definite and thorough training, that should render especially valuable their efforts as members of our national army—a training fully equal, we believe, to that of the corps of entomologists who are now rendering identical and signal service in the armies of our allies.

It is not our thought to propose by this resolution a specific classification or other plan of that nature; but rather to express our earnest wish to be of the utmost help, and to offer at this time a service which we believe and trust should be of genuine and special value.

Resolved, That the thanks of the Association be extended to the Carnegie Institute of Technology for the use of its buildings and apparatus and for the freedom of the

Museum and its valuable collections and especially to Dr. W. J. Holland for the many personal courtesies extended to the visiting entomologists.

E. D. Ball,
W. C. O'Kane,
F. C. Bishopp,
Committee.

By vote of the Association, the report was accepted and the recommendations adopted.

President R. A. Cooley: We will next listen to the report of the committee on membership.

REPORT OF COMMITTEE ON MEMBERSHIP

Your committee begs leave to report an increasing number of applications for associate membership in our association. Most careful consideration has been given to our recommendation for elevation of associate members to active rank, keeping in mind the value and extent of their economic entomological activities without being too greatly influenced by publications. Many associate members are so situated that facilities for personal publication are limited.

The committee recommends the elevation to active rank of the following associate members:

George G. Ainslie, Knoxville, Tenn.
George G. Becker, Fayetteville, Ark.
Donald J. Caffrey, Hagerstown, Md.
B. R. Coad, Tallulah, La.
E. N. Cory, College Park, Md.
C. W. Creel, Forest Grove, Ore.
Norman Criddle, Treesbank, Manitoba.
S. S. Crossman, Melrose Highlands, Mass.
W. P. Flint, Springfield, Ill.
M. M. High, Brownsville, Tex.
T. E. Holloway, Audubon Pk., La.
H. B. Hungerford, Lawrence, Kans.
J. L. King, Harrisburg, Pa.
H. O. Marsh, Rocky Ford, Colo.
Robert Matheson, Ithaca, N. Y.
W. R. McConnell, Carlisle, Pa.
Z. P. Metcalf, W. Raleigh, N. C.
Wm. Moore, St. Anthony Park, Minn.
G. E. Sanders, Annapolis Royal, N. S.
T. E. Snyder, Bureau of Entomology, Washington, D. C.
J. D. Tothill, Fredericton, New Brunswick.
T. D. Urbahns, Martinez, Cal.

The following are recommended for associate membership:

Ransom P. Allaman, Bedford, Pa.
R. H. Allen, Boston, Mass.
George Felix Arnold, Starkville, Miss.
Eric William Atkins, Station A, Ames, Iowa.
Floyd F. Bondy, Tallulah, La.
W. H. Brittain, Truro, Nova Scotia.
Dr. A. E. Cameron, Entomological Branch, Ottawa, Canada.
Wm. B. Cartwright, Knoxville, Tenn.
T. P. Cassidy, Tallulah, La.
Stewart C. Chandler, Carbondale, Ill.
L. H. Day, Hollister, Cal.
Dwight M. DeLong, Columbus, O.
Mack G. Dyess, Tallulah, La.
J. E. Eckert, Raleigh, N. C.
G. F. Ferris, Stanford University, Cal.
Anson L. Ford, Wellington, Kan.
Harold M. Fort, 201 College Ave., Columbia, Mo.
Stanley B. Freeborn, Univ. of Calif., Berkeley, Cal.
Stuart W. Frost, 119 Grove St., Tarrytown, N. Y.
Gwynn L. Garrison, Tallulah, La.
Samuel A. Graham, St. Anthony Park, Minn.
Geo. P. Gray, Univ. of Calif., Berkeley, Cal.
L. C. Griffith, Ithaca, N. Y.

Thomas L. Guyton, Ohio Agr. Exp. Sta., Wooster, O.
M. C. Hall, Detroit, Mich.
J. C. Hamlin, El Paso, Texas.
H. J. Herman, Falls City, Neb.
Albert Hartzell, Ames, Iowa.
F. B. Herbert, Los Gatos, Cal.
W. W. Henderson, Agr. Exp. Sta., Logan, Utah.
Chris M. Hunt, Gainesville, Fla.
H. G. Ingerson, Bur. of Ent., Washington, D. C.
Edward Roger Jones, University Sta., Baton Rouge, La.
Josef N. Knull, Hummelstown, Pa.
Merton C. Lane, Forest Grove, Ore.
James M. Langston, Forest Grove, Ore.
Horace Wilton Lee, Tallulah, La.
George Walter Luster, Tallulah, La.
George Maheux, Dept. Agriculture, Quebec, Canada.
E. J. Newcomer, Portland, Ore.
Raymond C. Osburn, Columbus, Ohio.
Wallace Park, Ames, Iowa.
J. J. Pillsbury, Providence, R. I.
James K. Primm, Oak Lane, Pa.
George H. Rea, Harrisburg, Pa.
Chas. A. Reese, Charleston, W. Va.
William A. Ross, Vineland Sta., Ontario.
C. L. Sams, Raleigh, N. C.
E. M. Schalck, R. F. D. 9, Rockford, Ill.
Henry H. P. Severin, Univ. of Calif., Berkeley, Cal.
Chas. E. Smith, Muscatine, Iowa.
Harris Pearson Smith, Tallulah, La.
Marion R. Smith, Washington, D. C.
C. F. Stahl, Spreckels, Cal.
Jacob R. Stear, 439 N. Market St., Wooster, Ohio.
Louis A. Stearns, Alma, Mich.
Charles F. Stiles, State University, Lexington, Ky.
A. L. Strand, 319 S. Black Ave., Bozeman, Mont.
Knowles Clark Sullivan, Columbia, Mo.
M. C. Tanquary, Manhattan, Kan.
F. M. Trimble, Primos, Pa.
E. S. Tucker, Baton Rouge, La.
R. K. Vickery, Saratoga, Cal.
Stuart Cunningham Vinal, Amherst, Mass.
Francis M. Wadley, Wichita, Kan.
E. V. Walter, Ames, Iowa.
C. A. Weigel, Columbus, O.
R. W. Wells, Bozeman, Mont.
Webb R. Williams, Tallulah, La.
H. E. Woodworth, 2237 Carlton St., Berkeley, Cal.
Martin Tranthan Young, Tallulah, La.

It is recommended that the resignations of R. J. Kewley, H. A. Preston, C. W. Loveland and W. R. Thompson, be accepted.

It is recommended that the Secretary send one more notification to members in arrears informing them that failure to immediately meet their obligations to the Association will result in erasure of their names from our membership list.

Respectfully submitted,

J. G. Sanders, *Chairman,*
J. J. Davis,
W. E. Britton,
Committee.

By vote of the Association, the report was adopted.

President R. A. Cooley: The next report will be by the committee on index to economic entomology.

REPORT OF THE COMMITTEE ON THE PUBLICATION OF THE INDEX OF AMERICAN ECONOMIC ENTOMOLOGY

Action at the last annual meeting authorized the Editorial Board of the Journal of Economic Entomology to publish the Index of American Economic Entomol-

ogy, 1905–1914, by Dr. Nathan Banks, and fix the cost of the volume, the attendant expenses being estimated at $1,300 for an edition of 1,000 copies.

It was hoped to issue the index by April 1, but delays almost inevitable in a technical volume of this size, and the difficulty on the part of the printer in handling the work, prevented sending out copies till May 20 and on the twenty-second the index had been mailed to all advance subscribers.

The total cost of an edition of 1,000 copies, including the binding of 300 (the remainder to be held unbound till needed), was $1,212.99. The advance subscription rate, limited to members and to be accompanied by a remittance prior to April 10, was fixed at $4.00 and after that the price was advanced to $5.00 for domestic and $5.50 for foreign subscriptions. There were 161 copies sold to advance subscribers and 58 additional to others prior to December 7, the date the books closed. The receipts from sales amounted to $928.50, leaving a balance against the work of $284.49. Since then nine other copies have been sold and these accounts are still outstanding. The indebtedness of $284.49 will be more than covered within a year or two, it is expected, by sales of stock on hand.

The index was not issued until so late in the year that it did not seem advisable to take any active steps toward securing the compilation of subsequent literature, especially as it would probably include at least three years and might perhaps be extended to cover a five-year period. The consensus of opinion among the committee favors the five-year period, though it is possible that after that time it may be feasible to issue the index annually and then combine it into a general index covering three- or five-year periods. The compilation of subsequent issues can probably be arranged with the Bureau of Entomology and it would certainly seem that that organization was better suited than any other to undertake such work because of the imperative need of the best library facilities.

It is recommended that the committee on the index of American economic entomology be continued and authorized to arrange for the indexing of the literature from 1915 to 1919 with a view to its publication later by the Association.

Respectfully submitted,

E. P. Felt,
W. C. O'Kane,
W. E. Britton,
A. F. Burgess,
W. E. Hinds,
Committee.

It was voted that the report be accepted and placed on file.

Mr. T. J. Headlee: I think a good piece of work like this ought to have its bit of praise, and I want the committee to understand that the index is sincerely appreciated. I have used it constantly since it came out and have found it to be of great service.

President R. A. Cooley: Is the advisory committee ready to report nominations for Journal offices?

Secretary A. F. Burgess: As far as I have been able to determine, only two members of the advisory board are present at this meeting,—Prof. Kellogg, who has left town, and Dr. Howard. No report has been filed and I presume no action has been taken. The Editor, Associate Editor and Business Manager of the Journal must be elected at this time, as the terms of the present officers expire. Under

the circumstances, I presume this could be done by a nomination from the floor.

Mr. Herbert Osborn: I move that the present officers be reëlected to fill these positions.

The motion was seconded and carried.

President R. A. Cooley: The report of the committee on nominations is now in order.

REPORT OF COMMITTEE ON NOMINATIONS

Your committee on nominations begs leave to place in nomination the following names for the offices stated:

For President: Dr. E. D. Ball, Madison, Wis.;

For First Vice-President: Prof. W. C. O'Kane, Durham, N. H.;

For Second Vice-President (Pacific Slope Branch): Prof. G. P. Weldon, Sacramento, Cal.;

For Third Vice-President (Horticultural Inspection Section): Mr. E. C. Cotton, Columbus, Ohio;

For Fourth Vice-President (Apicultural Section): Prof. Franklin Sherman, Jr., Raleigh, N. C.;

For Secretary: Mr. A. F. Burgess, Melrose Highlands, Mass.;

For Member of Committee on Nomenclature: Dr. E. M. Patch, Orono, Me.;

For Member of Committee on Membership: Dr. T. J. Headlee, New Brunswick, N. J.;

For Member of Committee on Entomological Investigation: Prof. G. A. Dean, Manhattan, Kan.;

For Members of Council A. A. A. S.: Prof. H. A. Gossard, Wooster, Ohio;
Prof. R. A. Cooley, Bozeman, Mont.;

For Advisory Committee of Journal of Economic Entomology: Prof. P. J. Parrott;
Prof. V. L. Kellogg.

Respectfully submitted,

Herbert Osborn,
A. W. Morrill,
W. J. Schoene,
Committee.

Mr. E. P. Felt: I move that the report be adopted and that the Secretary be directed to cast the ballot for the nominees. Carried.

President R. A. Cooley: I will therefore declare the members whose names have been read duly elected as officers for the ensuing year. Is there any miscellaneous business?

Secretary A. F. Burgess: I have not heard any recommendation by the membership committee or any other committees in connection with the boys who are members of this Association who have gone to the war. A considerable number are in the United States army and navy, and we have several members who are soldiers in the allied armies. I would move that the dues of officers or enlisted men, members of this Association in the United States or allied armies or navies, be remitted until the close of the war. Carried.

Mr. S. J. Hunter: I would like to move that the Secretary be instructed to prepare an honor roll containing the names of our members who are in various lines of military service. Carried.

Secretary A. F. Burgess: The balance of funds in the hands of the Journal is considerably less than last year. This is largely due to increase in price of everything going into the make-up of the publication. If we continue to publish as much material next year as we have published this year and get no more subscribers, we will have a very small balance to the credit of the Journal fund, if any, at the end of the year. The election of new members, in many cases, does not favorably affect the finances of the Journal. If 60 new members are elected and 40 of them have previously taken the Journal, the income of the Journal for the 60 members is $10 less than it would be from income of the 40 non-members. The reason for this is that a non-member pays $2.50 a year to the Journal, while a member pays $2.50 a year, but $1.00 of this amount goes to the Association fund. I am not opposed to the election of new members. I thoroughly believe in it, but we should understand that a large increase in membership does not necessarily mean a corresponding increase in the financial resources of the Journal. At present, the receipts of the Association are about $500 a year and the expenditures approximately $300. This leaves a balance of about $200. I think it might be wise, under conditions as they exist at present, to permit a transfer, if necessary, of a reasonable amount of money from the Association to the Journal fund during the coming year. I hope the receipts will be sufficient to meet all expenses, but as we wish to pay cash for everything, action along this line would seem desirable.

It was voted that the Secretary be authorized to transfer, if necessary, not to exceed $200 from the Association fund to the Journal fund during the present calendar year.

Mr. E. P. Felt: I would like to bring up some points concerning this matter as they affect the Editor, who is supposed to bear the burden if manuscript is carried a month or a year longer than the writer thinks it ought to be. As matters now stand, either the Journal board must determine how much shall be printed or secure an expression of opinion from the Association. It is not one of the principal pleasures of the Editor to decline manuscripts, but during the past year it has been necessary to refuse what would make nearly 100 pages of printed matter, and there are still a few manuscripts which have not been published. The policy has been for the proceedings of the Association to take precedence over everything else. Consequently, few papers can appear until June or later. In the June issue I outlined in part what seemed a fairly logical basis to follow under

present conditions. If we restrict ourselves pretty largely to new matter, we can handle the most important papers, except unusually long communications. Papers, it seems to me, fall into two classes,—lengthy and detailed reports which should be published as bulletins, and shorter papers which are important and cannot be handled readily by agricultural experiment stations or other agencies.

Mr. E. D. Ball: I think we often take a good piece of work and do not realize the benefit we derive from it. If there is a little error we do not forget to mention it, but we forget to mention the good things. I feel a very keen satisfaction and I have never heard any other expression in regard to the management of the Journal and also of the Index of Economic Entomology. We are proud of them and I think our Editor outlined a very definite and logical policy in his editorial,—one that is eminently just, and I move that we agree with the sentiments which he has expressed and facilitate its accomplishment.

Mr. W. J. Schoene: I would not like to see the Journal increase in size. I think Dr. Felt's method of handling the matter is very logical. I have had a little experience as an editor and I have found that workers sometimes are inclined to publish experiments rather than results. We want results rather than the details of the work.

Mr. T. J. Headlee: I agree with Dr. Felt's statements. I feel that the membership might help the Editor a great deal if it thoroughly understood or appreciated his position. My personal feeling is that the long article should be "tabooed," and that members ought not to send long articles to the Journal. If it were not for the probable "pinch" that is ahead of us, I would be very much in favor of increasing the size of the Journal, but under present conditions I would not suggest anything of the kind.

Mr. E. P. Felt: I would like to ask if it is desired to keep the Journal at approximately the same size during the coming year.

This was agreed to and the motion made by Mr. Ball was carried.

President R. A. Cooley: We will now take up the fixing of time and place of the next meeting.

Secretary A. F. Burgess: Professor Gossard, one of our representatives on the counsel of the American Association, has been obliged to leave early, but wished me to say that it had been decided by the council to settle the time and place of holding the next meeting or to dispense with the meeting if conditions made it necessary. He recommended that this matter be left with the executive committee of this Association.

It was voted that the matter be referred to the executive committee.

Mr. E. D. Ball: I move that the executive committee be instructed

to transact the necessary business of the Association during any interim that may exist before another meeting. Carried.

Mr. T. J. Headlee: The Ecological Society of America has appointed a committee to work out and define, if possible, the interrelationship of this Association and the Ecological Society, because they seem to believe that they could be of considerable aid to the economic entomologist. I have been asked to present this matter and suggest that a special committee be appointed to coöperate with the committee appointed by the Ecological Society.

By vote of the Association, the President was instructed to appoint this committee.

President R. A. Cooley: I wish to announce that I have communicated with Dr. Forbes by telegraph, and he has accepted the chairmanship of the special committee to which he was appointed. I wish to express my personal appreciation of the hearty and enthusiastic work of the committees and the thorough coöperation of all the members in making the program a success.

Adjournment.

PART II—PAPERS AND DISCUSSIONS

THE PRESIDENT'S ADDRESS

ECONOMIC ENTOMOLOGY IN THE SERVICE OF THE NATION

By R. A. Cooley, *Bozeman, Montana*

As we come together at this time on the occasion of the Thirtieth Annual Meeting of the American Association of Economic Entomologists two things are prominent in our minds: first, the fact of the great world war, and second, our desire to be of service to the nation. I have thought it desirable to review our status and to discuss economic entomology in the light of the national emergency, and in doing so I hope that what is said may be of interest to our Canadian as well as to our American entomologists. Necessarily, conditions in the United States will be discussed more particularly, but the underlying truths will be of wider application.

War, while most deplorable, is nevertheless a great teacher of lessons and may be a great impulse to progress. The needs of the nation as brought prominently to view by war, are but little different from those of peace, but they become intensified by the stress of the times and,

under the impulse of a national emergency, we may make, in a relatively short time, an amount of progress, which otherwise would require many years.

What are the lessons for the economic entomologist and how may we best apply them in this national emergency and also in the period following the war? May I say that in discussing this subject at this time I feel a considerable sense of responsibility and some misgiving. I am conscious that what I shall say may contain much that is old and little that is new. It seems perfectly clear, however, that such a discussion is desirable and can scarcely fail of being beneficial. We should not overlook the fact that economic entomology, although enjoying a rapid growth, is none the less incompletely organized, when the nation as a whole is considered. It is desirable that we should be willing, if necessary, to throw over any traditions that have served their purpose and in this grave hour approach new problems in the true spirit of science, with open-mindedness.

In the first place let us review briefly the facts which set forth the scope and importance of entomological service in the national welfare. They fall naturally under two general heads—agricultural entomology and medical entomology.

It is, of course, impossible to state with mathematical accuracy the amount of damage or loss to plants and animals or to plant and animal products through the attacks of insect pests. Without doubt the most comprehensive figures that have been given us are those of Mr. C. L. Marlatt, in his article in the Yearbook of the Department of Agriculture for 1904. The estimated total loss there given is $795,100,000. More recent figures by Professor Herrick of Cornell University in his "Insects of Economic Importance" place the loss in 1915 at $1,182,000,000, but since the value of agricultural products has increased so rapidly in recent years, and considering the present high prices, we are probably safe in placing the annual loss at the present time roughly at $1,400,000,000. Writers on this subject quite generally agree that the losses amount to at least 10 per cent of the total value of the crops. Thus wholly disregarding very large sums which entomologists have taught the farmer to save, possibly an additional 5 per cent, we are concerned, as a profession, with the saving of some $1,400,000,000 and at a time when 10 per cent of America's agricultural products might be enough to turn the balance in the war. It should further be pointed out that the losses occasioned by insects are to be deducted from the profits, and not from the gross returns, for the cost of producing a damaged crop is practically the same as of an undamaged one, excepting for a small extra item for harvesting the larger returns. This 10 per cent stands as our challenge. The great practical question is, can we by

special emergency efforts materially reduce this waste, or can the American people organize to accomplish this end?

Passing now to medical entomology we are concerned both with human life and health and with the economic welfare of our people, both of which are vital to the nation, in peace or in war. Dr. W. D. Hunter, in his scholarly address on medical entomology at our Cleveland meeting in 1913, summarized this subject for us and pointed out that, wholly in addition to the sickness, invalidism and deaths occasioned by diseases that are carried by insects and the human interest attached thereto, the nation suffers an annual economic loss of some $357,900,000. Here again the war emphasizes the importance of entomological service, and the conditions that obtain when man is about his ordinary pursuits are magnified many times over when army camps are established and when man power in civil life is in need of being conserved. We may place, then, a very high estimate on the value of the knowledge we possess concerning the insects which transmit diseases, as a factor in winning the war, as applied not only in the army but also in civil life.

Being actually confronted by a serious world shortage of foods and other necessary agricultural products, and with the allied nations looking to us to supply very largely what others lack, we find that the first and most urgent demand made upon us is in that branch of our service which we call extension entomology. Undoubtedly the next great forward step in economic entomology will be in this direction. In fact the change is already taking place. Some states have been making more than casual efforts in extension work and the passage of the Smith-Lever Act gave the movement a great impulse and was the first organized effort of national scope towards this end. Under this act, one by one, the states have been employing extension specialists in entomology. Since the opening of the war the Bureau of Entomology at Washington has been given a special emergency fund of $145,775 under the Food Production Act for extension or control work on insects. This is especially gratifying since it will do much towards saving crops, and is also very likely to be instrumental together with the Smith-Lever Act in bringing about, through the coöperation of federal and state authorities, the gradual establishment of a great national system through which a very large amount of effective extension work may be done. It is to be hoped that, once established, the system will be continued after the close of the war.

This whole movement is just now undergoing a very rapid evolution and it is of the greatest importance that while giving special attention to the present needs of the nation we do not overlook future needs but that we lay the foundations for a permanent extension system in ento-

mology. It is desirable also that during the period of the war, economic entomologists demonstrate in very practical ways the good that they can do for the nation. This will not only aid in winning the war but will at the same time furnish the reason for continuing the work. Thus the two interests are identical. As a nation we have not yet established the most effective organization of our official work in economic entomology. On the part of the states we have a greater variety of types of organization than is warranted by their needs. This applies more especially to the horticultural inspection work where we have in different states boards of agriculture, boards of horticulture, boards of entomology, state entomologists, either connected with the experiment station or not—all doing much the same class of service. Some states take a very active interest in the enforcement of inspection laws, while others show little interest. The United States Department of Agriculture has been following consistent and well conceived plans in its research work and the work of the Federal Horticultural Board, but as between the two,—the federal and the state agencies,—there has not been the fullest coördination.

The kind of organization of official entomology in the states has for the most part been determined by personalities and the personal wishes of those who were present in the state rather than in conformity to a nation-wide plan. I do not wish to be understood as advocating an effort at this time toward radical and rapid change of organizations though we may profit by observing plain principles of efficiency in any changes that may come up in the future, and it certainly is true that our profession would be better understood and of greater service if our organizations were less confusing to the public, to state officials, and even to ourselves. At any rate, now that we have the opportunity we will do well in setting up an extension organization to follow well formulated plans and to be as uniform as possible.

For the purpose of securing authentic information regarding the status of organized state extension work, especially that under the Smith-Lever Act, a questionnaire was addressed to the several states. This has elicited information, which is tabulated on page 20.

An examination of this table shows, and the replies and correspondence show more fully, a number of interesting and important conclusions.

(1) Extension entomology is not yet generally organized as a separate division, coördinate with teaching and experiment station work. Out of 48 states, 12 have organized or are now undergoing organization, 36 have not organized. A few states, while not organized in the sense intended in the questionnaire, are giving careful attention to extension and survey work. Under those states reported as not

Extension Entomology under the Smith-Lever Act

	Organized or not?	Extension Entomologist?	Member Ent. Dept.?	Directed by Ent. Dept. or Ext. Serv.?	Head of Dept. formally recognized by Ext. Serv.?	Head of Dept. informally consulted?	Special fund?	
Alabama	No	No	......	......	Yes	......	No	Some work done by State Entomologist
Arizona	No	No	......	......	No	Yes	No	Some work done by State Entomologist
Arkansas	No	No	......	......	No	Yes	No	Some work done by Extension Horticulturist
California	No	No	......	......	No	Yes	No	Some work done by other agencies
Colorado	No	No	......	......	No	......	......	Extension work being done, in part, informally through Extension Service
Connecticut	No	No	......	......	No	Yes	......	Some ext. work done by State Entomologist and some by Extension Service
Delaware	No	No	......	......	......	......	......	No Entomologist
Florida	No	No	......	......	......	......	......	State Plant Board doing extension work
Georgia	No	No	......	......	......	......	......	All work done by Horticultural Department
Idaho	No	No	......	......	No	Yes	......	Station Entomologist works with county agents
Illinois	......	No	......	......	......	......	......	Well organized under the Entomological Survey
Indiana	No	No	......	......	No	Yes	......	
Iowa	No	No	......	......	......	......	......	
Kansas	Yes	Yes	Yes	Both	Yes	......	No	
Kentucky	No	No	......	......	No	Yes	No	Some extension work done informally
Louisiana	No	No	......	......	......	......	......	
Maine	No	No	......	......	No	Yes	......	
Maryland	Yes	Yes	Yes	Both	No	Yes	No	Temporary emergency organization
Massachusetts	No	No	......	......	No	Yes	No	Extension work done informally. Slight amount of work done by other agencies
Michigan	Yes	Yes	Yes	Both	Yes	......	No	
Minnesota	No	No	......	......	No	Yes	No	State Entomologist and assistants do extension work
Mississippi	No	No	......	......	No	Yes	......	Some extension work done informally
Missouri	Yes	Yes	No	Extn. Serv.	No	Yes	Yes	
Montana	No	......	......	......	No	Yes	......	Organized under state entomologist fund
Nebraska	Yes	Yes	Yes	Both	Yes	......	No	
Nevada	No	No	......	......	No	Yes	......	
New Hampshire	No	No	......	......	Yes	......	No	Special control and education conducted by State Department of Agriculture
New Jersey	Yes	No	......	......	Yes	......	Yes	
New Mexico	No	No	......	......	......	......	......	Biologist in charge of work
New York	Yes	Yes	Yes	Both	No	Yes	Yes	Other agencies do some work
North Carolina	No	No	......	......	Yes	......	No	
North Dakota	No	......	......	......	......	......	......	Some work done by State Dept. of Agric.
Ohio	......	No	......	......	Yes	......	No	Extension work done by University Experiment Station and other agencies
Oklahoma	No	......	......	......	......	Yes	No	Extension work done informally
Oregon	......	Yes	No	Extn. Serv.	Yes	......	No	Extension entomology combined with plant pathology
Pennsylvania	Yes	Yes	No	Extn. Serv.	......	......	Yes	No entomology department in college
Rhode Island	No	No	......	......	......	Yes	No	
South Carolina	Yes	Yes	Yes	Ento. Dept.	Yes	......	Yes	
South Dakota	Yes	Yes	Yes	Both	No	Yes	Yes	
Tennessee	Yes	No	......	......	Yes	......	Yes	Head of department doing extension work without assistants
Texas	Yes	Yes	No	Extn. Serv.	No	Yes	Yes	
Utah	No	No	......	......	No	Yes	No	
Vermont	No	No	......	......	......	......	......	Some extension work done by other agencies
Virginia	No	No	......	......	No	Yes	No	Some extension work done by other agencies
Washington	No	No	......	......	Yes	......	No	Some extension work done by other agencies
West Virginia	No	No	......	......	No	Yes	No	
Wisconsin	No	No	......	......	No	Yes	No	Some work done by other agencies
Wyoming	No	No	......	......	No	......	No	No entomologist

organized are included several which have no official entomologists or have their pest control work done by biologists or zoölogists. States reported as not organized are in many cases doing extension

work in the old, informal way, generally on demand from the farmers or from official agencies of the state.

(2) With the exception of two states, those states reported as organized have extension entomologists. Thus there are reported 11 states having extension entomologists. Seven states report assistants to the extension entomologist of one sort or another.

(3) Of the 11 states reporting extension entomologists, 7 state that the man engaged in this work is a member of the entomology department while in 4 states he is not so connected.

(4) In all cases where the extension entomologist belongs to the extension organization and not to the entomology department he is under the direction of the extension service only. Where he is a member of the entomology department he is in all cases jointly directed by the head entomologist and the extension service, excepting in South Carolina, in which state he is wholly under the entomology department. When directed by both there is some variation as to his relationship to each.

(5) Several states did not answer the question relative to whether the head of entomology is formally recognized or informally consulted by the extension service. Of 35 reporting 11 state that the entomologist is so recognized, and 24 report that he is not. When not formally recognized he is generally informally consulted.

(6) In 8 states only is a special extension fund reported outside of salaries, but several report funds as needed from the extension service.

(7) Many states report more or less extension work being done by other agencies.

(8) In Georgia all such extension work is done by the horticultural department.

(9) In one state, Oregon, the work in both entomology and plant disease is being done by one extension man.

In the states we have not yet, in most cases, established the most effective organizations under the Smith-Lever Act. To be sure the extension organizations in the states are for the most part quite new but with the experience we have had already a number of reliable conclusions affecting entomology appear to be indicated.

As a step toward a further recognition of entomology under this act it is very desirable that entomologists themselves fully recognize the importance of this new development and that a form of organization which provides for the solution of various perplexing questions be outlined, and brought to the attention of the suitable officials in the states. Extension entomology urgently needs more than occasional or casual attention. Research and experimentation have gone far ahead of extension, and entomologists are in possession of a vast

amount of valuable information which the farmer does not have or which he imperfectly understands. The result is that losses continue which might be prevented and in many instances the farmer does not know even that his crops are being injured. Even now under emergency conditions there is a strong tendency to overlook average losses and pay attention only to conspicuous outbreaks of pests. The importance of this work, especially in view of the world shortage of food, clothing and other necessities, and the prospect for a long continued shortage in these staples, can scarcely be over-emphasized.

The work in the several states under the Smith-Lever Act has led to the appointment of a large and rapidly increasing number of county agents. This has greatly increased the demands for state work and has created an opportunity for definite constructive entomological work among the farmers. To carry on such work successfully there must first be the right kind of organization. It seems, therefore, that the logical and feasible first step is to establish extension divisions in the entomological departments connected with the land grant colleges. Wherever possible there should be extension entomologists in each state giving full time to the development of this work, unless the state has an effective way already inaugurated.

I do not wish to be understood as minimizing the control work that is being done in some states by organizations away from the land grant colleges, or under special appropriations by entomologists connected with such colleges but not articulated with the extension service. Where such work is being done it should be continued and encouraged, especially during the present emergency, but at the same time we should realize that the Smith-Lever Act recognizes, officially, only the land grant colleges in the several states and I believe it is through this new extension organization that an effective nationwide system may be built up.

In chronological order the next important step in the development of extension work is that being inaugurated at the present time by the Bureau of Entomology under the Food Production Act which was approved by the President August 19, 1917. This has already been mentioned above. Under this act the Bureau of Entomology has organized an Office of Extension Work in Entomology. Project agreements between the Bureau and the Extension Services of the several states are being entered into. These agreements provide for the placing of specialists from the Bureau in the states who will be directed coöperatively. These men are under the immediate direction of the extension services of the states where they are employed but the general plans will be as agreed upon between the state and federal authorities. A project to increase production in a given state or re-

gion or to carry out other provisions of the Food Production Act in other lines of agricultural work can, in most cases, be definitely planned in advance but insect outbreaks are often sporadic and always regional and the Bureau of Entomology reserves the right to detail the specialist to another state if a serious outbreak makes this necessary. It will strengthen the work in the various states if when the emergency has passed, the Bureau's specialist be returned to his original station.

Rather definite plans are, of course, needed on the part of the states in order that the fullest use of the Bureau's specialists may be made. A part of the work of the year can in most cases be laid out in advance and clearly it is desirable that any state, for the purposes of extension work to be done either in coöperation with the Bureau of Entomology or independently, should have definite information regarding the relative importance of the various crops grown in the state and regarding also the relative amounts of damage done by the different pests. Pest survey work is of the greatest importance in this connection. Only with such definite information before the entomologist, can the most useful work be undertaken.

The emergency extension work carried on by the Bureau of Entomology makes it more important than ever that each state should have its own extension entomologist. Mr. J. A. Hyslop, who has been charged with the direction of the extension office of the Bureau of Entomology, emphasizes this point in a recent letter in which he suggested that an extension entomologist should be appointed in every state, and that he should be the project leader in all coöperative entomological extension projects in that state. The great danger at the present time appears to be that the state will in many cases be content to stop with the securing of one of the Bureau's specialists. The federal specialist can be much more effective if he works in coöperation with the local man who is following a comprehensive plan for meeting the state's needs.

From every standpoint it is very desirable that the extension entomologist should be a member of the entomology department of the institution and that the head of the department have the closest relationship with the extension director in planning the extension work in entomology. The department can do much for the extension entomologist and for the state through him, and he in turn can do much for the department by keeping it in touch with the needs of the state. Teaching, research and extension may all be benefited by being coördinated through one head. However, some states have already organized with the extension entomologist independent of the department of entomology in the institution, and in one state at least the only connection which the entomology department has with the

extension work is through informal conferences. As a general principle the work of the land grant college in extension work should be the work of the departments, as in the case in both the experiment station and in the college, and not the work of an independent organization out of touch with the college departments. Others have stated this before me. The heads of departments should be a part of the extension organization or a part of an extension council in which general policies are discussed.

The fact that there are county agents in the field under the direction of a state leader and that these are the persons through whom, or in coöperation with whom, the specialist from the college does certain of his work, introduces a factor not found in the experiment station and for which special provision has to be made. Clearly the county agents must be coördinated through the state county agent leader and the specialist clearly must do his work with the agents through coöperation with the leader. The county agent has many duties to perform and what he does for or with the state specialists must bear an orderly relation to his other duties. The county agent necessarily does many things for the farmer on his own initiative or on request from the farmers and he must call upon the college departments for aid. Thus the initiative for new work may naturally come from the county agent, the county agent leader, or the state specialist. Clearly then there should be laid down an orderly procedure. The fullest usefulness can come only from the fullest coöperation and the fullest coöperation can come only through having a well understood and accepted channel of communication. Any initiative coming from the college should be the result of conference between the extension service and the college department and any communication with the county agent should be through the leader or with his knowledge in each specific case if any claims on the county agent's time are contemplated.

The plan in various states of having the extension service direct the time and the routing of the specialist is probably the best that can be devised but the departments alone should be responsible for the information and instructional programs which the specialist dispenses. Recommendations concerning titles and salaries should emanate from the department of entomology. The head of the department should take a very active interest in the success of the work in the field.

The extension entomologist has for his main object the saving of as much as possible of the 10 per cent loss of agricultural products. He has laid out before him a field of great opportunity and of great possibilities. He may work through the farmer himself or through the farmer's children in the schools. He may use lectures, circulars and the agricultural, weekly and daily press. He may conduct demon-

strations and prepare charts and exhibits. He may prepare elementary textbooks and in short he has an opportunity of building up a great system of public instruction. He will need enthusiasm and he should not only lead the farmer to see what he should do but get him to actually do it.

This program suggests a number of things that economic entomologists in general should do for the assistance of the extension entomologist. Among these I would mention what may be called standardization of methods of control. By this I mean the general and official adoption of uniform or standard methods of control for as many as possible of our insect pests, such standard methods to become the basis of systematic public instruction. I believe that one principal reason why we have not made greater progress in leading farmers to actually control more of the insect depredators is that we have lacked sufficient definiteness in our recommendations. One entomologist has recommended one thing and another has proposed a second while perhaps the more general practice has been to recommend several methods and leave the farmer to choose for himself. The result has been in too many cases that the farmer has tried none of them. We must remember that the farmer is not a specialist, let alone an entomological specialist. He is not prepared to decide between remedies. How can we expect him to do what we have failed to do? Yet if he does anything it must be something definite and he must have reasonable assurance that what he does will repay him for the time and money expended. He can reasonably ask this of us; we can afford to offer nothing less. I realize very fully that there are limitations to the idea of standard methods, and that I am liable to be misunderstood. The control of insect pests cannot be reduced to a rule of thumb, and yet I believe that we can do much to facilitate the work of the extension entomologist and of the farmer by making a beginning in what shall be a continuous effort toward bringing together such statements of control methods as the farmer can and will use. A standard control method may vary with the climate, number of brood and other known factors in different localities. Let me say that because there are at present few if any insects for which we have sufficiently definite information to enable us to set up standard control programs, is no reason why we cannot with fuller information set up such programs. There certainly is truth in the assertion that climatic and other conditions vary in different parts of the country and that correspondingly the life-histories and habits of insects and their responses to insecticides vary, but it is just as true that in many instances we have failed to work out the variations and have left the farmer in the dark. Most certainly our duty is to discover the effects of these varying factors

and to make them clear to the farmer. If extension entomology is to become more than a sporadic affair, and is to assume the proportions of a worthy national movement, we must show that the advice given will benefit the farmer in a very practical way. We do not make a consistent showing if under the same climatic conditions one state recommends one thing for the control of, say the apple leaf aphis, while the next state, under practically the same climatic conditions, recommends another or if a third state equally interested overlooks the insect altogether in its official publications.

I look upon the present movement in extension entomology as era making. Economic entomology as an abstruse science, out of vital touch with the needs of mankind, would have very little reason for continuing and the science will grow and develop in proportion as it meets human needs. Economic entomology in America has been practical, indeed very practical, but the time has come when we should make the taking of the products of research to the farmer a definite scientific enterprise.

Closely related to extension entomology is the special control work being done by entomologists under appropriation made to meet specific needs. The organization in the states most likely to be charged with conducting such work is the one best qualified to conduct it, but because of the style of organization and methods used there seems to be no reason why this may not be connected with the work of the extension entomologists or conducted with it coördinately through the head of the department. As rapidly as sufficiently definite information and special appropriations can be secured such special control projects should be started.

Some comments on research entomology are pertinent. I have said that we are in need of more definite practical information concerning the control of our common pests. To meet this need we shall in many cases have to go back and conduct many experiments and minor studies to clear up practical points. Men of wide experience should direct these studies. The more formal and fundamental studies of the research entomologist are if anything more urgently needed now than before and I would not in the least minimize projects under the Adams fund which generally require several years for their completion, yet we must recognize also that we need funds for less formal studies. The sporadic nature of insect outbreaks affects research work as well as extension and quite often problems which vitally affect the saving of crops, come up for solution suddenly and need immediate attention. We must, therefore, provide for flexibility in our plans.

In the present great national emergency we must be willing to do anything necessary within our power to increase the supply of

plant and animal products and we should be willing even to lay aside for a time our research work and meet emergencies. Without doubt our directing officials will approve. A safe rule to follow is to continue the old work unless there is a real reason for a change.

Law enforcement to prevent the introduction and spread of insect pests will probably be little affected by the movement in extension entomology other than the benefit that will result from a wider knowledge of insect pests. It should be said, however, that in view of the national and of the world conditions we should increase rather than slacken our efforts to prevent the dissemination of dangerous species. Growing out of the shortage of foods there has been an increasing tendency on the part of the public to demand a slackening in the inspection and quarantine regulations. International commerce has been revolutionized during the war and after the war is over still more extensive changes may follow. Just what the special needs of the hour will be then we cannot say now, but it is clear that the inspection service will be greatly needed.

During the period following the war, and in connection with the development of a national system of extension entomology now under way, it is probable that the teacher of entomology will find much to do. In the first place an increasing number of well trained men will be needed. From the present indications there is very little danger of overcrowding the profession. There is much more danger that there will be a serious shortage of suitably trained men during the next ten years. Naturally the demand will be not alone for extension entomologists, but for investigators, inspectors, directors of control projects under special appropriations and teachers as well. From the professional standpoint the outlook in entomology is very bright, and we should give renewed attention to the further development of means and methods in teaching entomology in the college and university.

Now as never before the entomological departments of our colleges and universities require at the head men who will give attention to the broader aspects of economic entomology. The time is passing when the narrow specialist who overlooks the needs of his state can continue to give satisfaction as an administrator. We need to give full attention to the development of what may be termed state systems of entomological service, and through the fullest joint coöperation between the United States Department of Agriculture and the states, develop a more effective nation-wide system. It is possible that a committee of this Association ought to work out a plan for taking definite steps to facilitate this. We need to submerge local interests and seek to promote first the general good in order that economic entomology may render the fullest service to the nation.

President R. A. Cooley: I will call on Mr. O'Kane to present his paper:

TAKING STOCK

By W. C. O'Kane, *Durham, N. H.*

(Withdrawn for publication elsewhere.)

President R. A. Cooley: I feel especially grateful to Professor O'Kane for this paper. It is before you for discussion.

Mr. H. A. Gossard: I feel very grateful to Mr. O'Kane for assembling this information, together with charts. I have no doubt that it represents a great deal of truth. I was wondering, however, if Professor O'Kane didn't feel sometimes as though he would like to turn aside his mathematical method of putting in those lines. For instance, suppose we come to such a question as gipsy moth control. If I were looking at the reports from an entomologist like Mr. Burgess, who had given a great deal of time to that insect, and to reports of two or three other entomologists, and I found those agreeing, I would certainly give more credit to them than I would if a hundred entomologists, with whose work I was unfamiliar, reported on that problem. The same thing would apply if I found Professors Davis and Forbes agreeing on a point: I would be inclined to accept these two judgments and not the ninety-eight judgments of some others. I am wondering if Professor O'Kane didn't find a few times when the consensus of opinion failed to represent the exact truth of entomological knowledge.

Mr. W. C. O'Kane: The majority of the entomologists left out the insects of which they had no personal knowledge. The replies concerning gipsy moth came from those states in which gipsy moth occurred and in which they had experience with it. The percentages are fixed on those that actually gave their experience with the insects. I confess to a feeling such as you have, precisely. I made out no chart myself and endeavored to leave myself out of it in tabulating and simply took, as you said, the volume.

Mr. S. J. Hunter: It seems to me that this is one of the most illuminating articles we could possibly have, coming after the President's address. If I get the tenor of it, when the President's address is carried into effect, the three lines: the dotted, dash and straight line will fuse. I expect to have these charts reproduced in large size and use them in my classes in entomology.

Mr. J. J. Davis: This certainly has been a very suggestive paper and much appreciated, but I feel exactly as Professor Gossard does, in that I don't believe it presents to us the true state of affairs as they exist.

Take, for instance, the Hessian fly. The farmer control of the Hessian fly was at zero. I have worked a little on the Hessian fly in the past year and I don't believe we can say that the actual control of the Hessian fly is as low as the zero point, and I can't understand how the questionnaires could have reproduced, if they were the actual state of affairs, a zero result in the control of the Hessian fly. We realize that it is lower than it should be, but how it could be zero is unbelievable.

MR. W. C. O'KANE: I said that nobody had complete control. Mr. Davis is right about the point he mentioned, and the dotted line, if the paper is published, should be very clearly made to indicate the opinion of entomologists as to complete control security; also partial control security, and I think that will be made clearer in the paper itself. As to actually securing complete control, everybody said we didn't get it.

PRESIDENT R. A. COOLEY: Do you wish to discuss the paper further? If not, we will adjourn.

Adjournment, 12.20 p. m.

Afternoon Session, Monday, December 31, 1917, 1.45 p. m.

PRESIDENT R. A. COOLEY: The first paper entitled "Texas Aphid Notes," by F. B. Paddock, will be read by Mr. Bilsing.

TEXAS APHID NOTES

By F. B. PADDOCK, *State Entomologist, College Station, Texas*

Upon a review of the literature on this family we find but few references to the aphids in Texas. In 1906 Sanderson[1] records some rearing notes on the European grain aphis, *Macrosiphum granaria* Buckt. The first paper on the economic phase of a Texas aphid was by Professor Webster in 1912[2] on The Spring Grain Aphis or "Green Bug." The next paper was in 1915 by the writer on the turnip louse.[3] From time to time in other publications the distribution of an aphid has included some portion of Texas. No List of Texas aphids has been published, although some material has been collected and a few notes have been made by some of the former entomologists of the Texas station. This group of insects has not attracted the attention of collectors passing through the state as have other groups, as Jassids, Orthoptera, Coleoptera, and Hymenoptera.

[1] Texas Notes II. E. Dwight Sanderson, *Macrosiphum granaria* Buckt. Entomological News, November (page 327), 1906.

[2] The Spring Grain Aphis or "Green Bug." Webster and Philips. Bureau of Entomology, Bulletin 110.

[3] The Turnip Louse. F. B. Paddock. Texas Station, Bulletin 180.

From the records that have been made and personal observations it would seem that the species of this family are not as abundant in Texas as in other states. This may be partly due to the natural factors, which will be mentioned later, but perhaps largely to the fact that sufficient work has not been done on the group. A few new species have already been found, and it is to be expected that future work will reveal the presence of other new species as well as more of the old species.

The fact that no considerable amount of work has been done on aphids should not be taken to indicate that this group of insects is not important in this state. As a matter of fact, the economy of this state is disturbed as much by the presence of aphids as in any other state. Among the destructive species that might be mentioned are the "green bug" *Toxoptera graminum* Rond., the melon or cotton louse, *Aphis gossypii* Glover, the turnip louse, *Aphis pseudo-brassicæ* Davis, the oat louse, *Aphis padi* Linn, and the corn-leaf aphis, *Aphis maidis* Fitch. The periodic losses by the green bug are very severe and are well known; the growing of melons and cucumbers have been abandoned in some sections on account of the melon louse, and the same is true of turnips and related plants subject to the attack of the turnip louse. Acres of oats are annually destroyed by the oat louse, although it is not appreciated that the loss is caused by this insect. Much corn (*Zea mays*) and sorghum are badly stunted every year by the corn-leaf aphis, although this condition of the plants is popularly supposed to be due to the dry weather.

In the work that has been done to date, several variations in the general aphid life-history have been found. Most noted of these is the absence of sexes in the seasonal history of the aphids. The general statement has been made by Webster (*l. c.*) that south of the 35th parallel the sexual forms of plant lice have been observed but rarely except at high altitudes. Sanderson (*l. c.*) in 1906 reported the occurrence of the development of sexual forms of *M. granaria* in rearing cages at College Station. The next occurrence of sexual forms was recorded by Yingling in 1916 when eggs and oviparous females were taken in the field near College Station. This year, specimens of eggs and oviparous females of *Longistigma caryæ* Harris[1] were taken at Boston in northeastern Texas. Although the sexual forms of the oat aphis, the cornleaf aphis and the green bug occur throughout the north, they have not yet been found in Texas. In the case of the green bug, a very careful search was made, but the other species have not yet been thoroughly investigated. With the melon louse and the turnip louse the sexes have not yet been taken, even in the north.

[1] Determined by Prof. H. F. Wilson.

Of the species of aphids carefully investigated to date, the normal form of reproduction is asexual throughout the entire year. This has been found to be the case in the green bug, the turnip louse, and the melon louse. Even as far north in the state as Witchita Falls, close to the 34th parallel, viviparous development of aphids persists throughout the winter. Here an inch of snow is not uncommon, which may sometimes remain on the ground for four or five days. Temperatures of 15 to 20° F. are not rare and there may be periods of a week when the temperature is not over 32° F. Under these conditions, the turnip louse and the green bug survive, and reproduction is only retarded. In the extreme southern section of the state where freezing temperatures are uncommon, asexual reproduction proceeds uninterrupted. In January at Brownsville the daily reproduction in the turnip louse was six to eight young, equal to ideal autumn conditions at College Station. At Brownsville, Vickery reared 107 successive generations of the corn-leaf aphis. Only 35 successive generations of the turnip louse were reared at College Station but these occured in twelve months. Sixty-two successive generations of the melon louse have been reared at College Station in twelve months. In all of these cases, no sexual forms have appeared.

In Texas, the summer conditions are more severe for the aphids to withstand, than are the winter conditions. During the very long, hot and dry summers, green succulent vegetation is found in only low, damp and protected places. With the green bug, the migration from grain occurs during June and July, which is the time of the ripening of the grain. During the summer, it was impossible to find any lice in the grain fields, and even if the growing grain was available at this time, it is doubtful if the green bug could survive the temperatures which prevail. It was with much difficulty that the turnip louse was reared throughout the summer on turnips when none were to be found in the field. The melon louse feeds entirely on cotton and okra during the summer months, these hosts being the only ones that are available at that time.

In the turnip louse, with the approach of hot, dry weather, there is a decided reduction in the number produced daily, and all of the stages of life-history are lengthened much the same as under winter conditions. The same condition has been as pronounced in the melon louse in our cage rearing experiments. The month of August seems to be the most severe in the year for the aphids to withstand. During the summer months, general collection of aphids is almost impossible, the spring and fall months being the best for collecting purposes.

In one case, we find a complete reversal of the life-history in the beet louse, *Pemphigus betæ* Doan. The alate viviparous females of

this species may be found on the foliage turnips during October. The apterous females feed on roots of this host throughout the winter, sometimes causing an appreciable loss in truck gardens. The alate forms are found on the foliage again in March and later are taken on cottonwood. On this host, the summer is passed in galls on the leaves. No eggs for this species have yet been observed.

But little attention has yet been given to the economic problems of aphids in Texas, consequently there is a great amount of work to be done in the future. Although extended studies have been made on a few species, the alternate host plants have not been established for a single species. Further work along this line should be fruitful of results.

PRESIDENT R. A. COOLEY: I will now call for Mr. Hartzell's paper, "A Method of Graphically Illustrating the Distribution of Injury by an Insect Pest."

A METHOD OF GRAPHICALLY ILLUSTRATING THE DISTRIBUTION OF INJURY BY AN INSECT PEST

By F. Z. HARTZELL, *Vineyard Laboratory, New York Agricultural Experiment Station, Fredonia, N. Y.*

In the study of an insect pest, it frequently becomes necessary to investigate the feeding habits of the species together with the movement of the pest in cultivated areas. In such a problem, the labor of the economic entomologist might be divided into two sections: (1) to determine the relations of the insect to the environmental complex; (2) to describe and illustrate these relations accurately and concisely. Various methods can be used to accomplish this result but the writer believes that the simplest and best for the average worker is some form of graphical representation. The use of graphic charts and solid models is common in the study of intricate problems of physics and engineering. If these methods can be adapted to the study of the problems of entomology, the workers in this science will have a vast literature to assist them. The marked superiority of graphical representation over tables or descriptions is sufficient justification for the use of such types of charts.

A common method of illustrating the amount and distribution of insect injury is a map of the infested area in which the varying degrees of injury are represented by shading. This is not sufficiently accurate and does not show the quantitative results we desire. A more accurate method would be to divide the area into small squares and to

indicate the average amount of injury in each square by a number. However, there is apt to result a mass of data which is more or less confusing unless the work is carried farther. If, in addition, we use orthographic projection, representing the amount of injury as an elevation, and interpolate sufficient points having the same elevation, it will be easy to connect these points by means of smooth curves or contours. Each contour is numbered to show its elevation. In other words, we have a topographic map in which the contour lines represent places having equal amounts of injury. The work can be carried to the degree of refinement desired. Unless the detail is too intricate, a slight effort of the imagination will give a good idea of the undulating surface which such contours represent. The weather map is a familiar example of such a chart. The terms isotherm, isobar, and isohyetal lines, as applied to the contour lines in meteorology, are current. Since the chief injury by an insect is generally produced by its feeding, we have designated the line showing equal amounts of injury an *isofag* ('ἴσος, equal+φαγεῖν, to eat). In certain instances, similar lines may be used to show the distribution of equal numbers of insects but here the term *isopleth* ('ισοπληθής, of the same number) might be used, although it should be stated that *isopleth* is used in another sense in mathematics.

Theoretical Considerations

We will assume vast numbers of a migratory species located in a very restricted area in the center of an extensive field having a uniform crop so the pest is at liberty to move with equal ease in any direction. We will further assume that every environmental influence is exerted equally in all directions. Now, as the insects continue to feed it will be necessary for them to migrate and in this movement each insect will fly a short distance. In this general movement usually all food will not be destroyed in the path of the infestation. Since the insects can move in any direction with equal ease—except perhaps toward the center of infestation owing to conditions brought about by their own feeding—it is probable that points equally distant from the center of infestation will sustain an equal amount of feeding. If we map this area and represent the injury by *isofagal lines*, we would find them to be concentric about the original area of infestation. These are shown by the lighter concentric circles in Figure 1. On the other hand, if all these conditions exist except that one influence, as for example, the wind, tends to carry the insects farther in one direction than any other, on mapping such an area, it will be found that the *isofags* would be oval and eccentric about the original area of infestation. These are also shown in Figure 1. Under conditions where the results approach

the uniformity found in this illustration it would be possible to analyze the data and determine mathematically the effect of the disturbing factor. We will omit the mathematical phases in this paper. However, in mapping insect injury, if the center from which the insects spread can be ascertained, the use of concentric circles (or sectors of such circles) about this area if added to the map will indicate the divergence from uniformity.

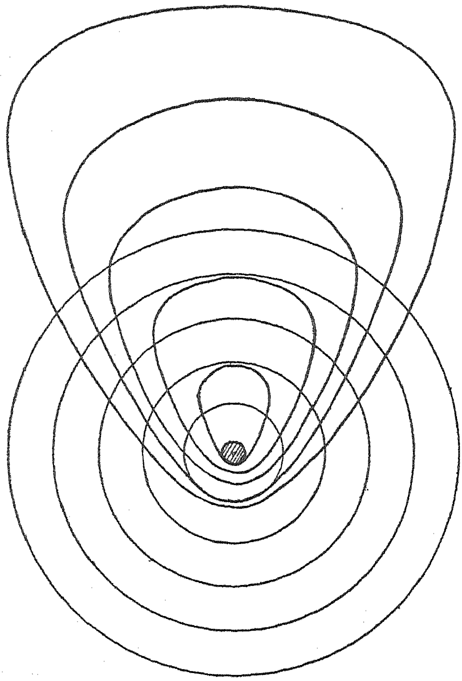

Fig. 1. See text for explanation.

Mapping the Area

In this phase of the problem, we adopt the principles of topographic surveying, the only difference in field work being in vertical control. The first step is to divide the infested area into small subdivisions, preferably squares, and to make a map of the same. The most practical instrument for this use is a small traverse plane table with compass and alidade. In horizontal control, the methods of locating points are those used in plane table surveying, the details of which are given in works on this subject. In surveying, vertical control consists in ascertaining the elevation of primary stations, traverse stations and selected points in the area surveyed, the instruments used being the level or aneroid barometer. Vertical control in mapping insect injury consists in determining the average amount of injury for each subdivision of the infested area and assuming this average to be located at the center of the subdivision. The method of ascertaining the amount of injury will be determined by the nature of the feeding, the degree of precision desired and the speed required. This demands that each investigator must formulate his own methods. The speed required should be determined first. It is essential that the injured area be mapped before any marked changes occur which might tend to obliterate the injury to be determined. Perhaps the most important changes will be produced by the growth or death of the plants infested

and precautions must be taken to maintain the same degree of precision throughout the survey. The results will be more accurate if a moderately precise method be used to determine the amount of injury and the survey be completed before any marked changes occur, than if a more exact method be used but one which reduces the speed to such an extent that decided changes occur before the determinations are completed.

The size of the subdivisions is important. In a vineyard or an orchard, the individual vine or tree may be taken as the unit. These are easily located and can be combined into larger subdivisions if necessary. With field crops, the size of the area should be such as will give a sufficient number of points to determine the isofags to the degree of accuracy required. If undecided as to the size of the subdivisions, it is better to err in making the plots too small rather than too large for, if necessary the small plots can be combined into larger plots, whereas, if made too large, one has no opportunity of correcting the error.

The plotting of the isofags is accomplished in the office by methods of interpolation. In this portion of the work one should use a sufficient number of points to determine the contours so as to show variation in considerable detail but excess of detail should be avoided, as this is apt to make the chart confusing. For the same reason the contour interval should not be too small. We are interested in averages, so too great detail tends to obscure the general trend of the facts and, moreover, requires an amount of labor in plotting that is not justified by the problem.

A Practical Example

On June 4, 1914, our attention was called to a vineyard that was severely injured by the grapevine flea-beetle (*Haltica chalybea*). This insect injures the grape by destroying the swelling buds in the spring. The vineyard was near Sheridan, N. Y., and consisted of about 6.5 acres having 4,097 vines (77 vines missing). It was situated just east of a woodland and northeast of a section of waste land containing approximately fifty acres in which latter were growing great masses of wild grapes, practically all belonging to the species *Vitis bicolor*. The beetles, which hibernate as adults—evidently had greatly multiplied in this area the previous season and during the spring of 1914 invaded this vineyard. Although grapes were cultivated to the southeast, south and west of the waste land, the injured vineyard was somewhat isolated.

On our first visit, it was evident that the injury was not uniform throughout the vineyard and, as it seemed to present a problem that needed further study, we made a map which showed the location and

percentage of injury of each vine in the vineyard. After studying the map we tried various forms of graphic representation but found nothing better than the topographic chart to show the variation in injury in different portions of the planting. We divided the vineyard, as far as

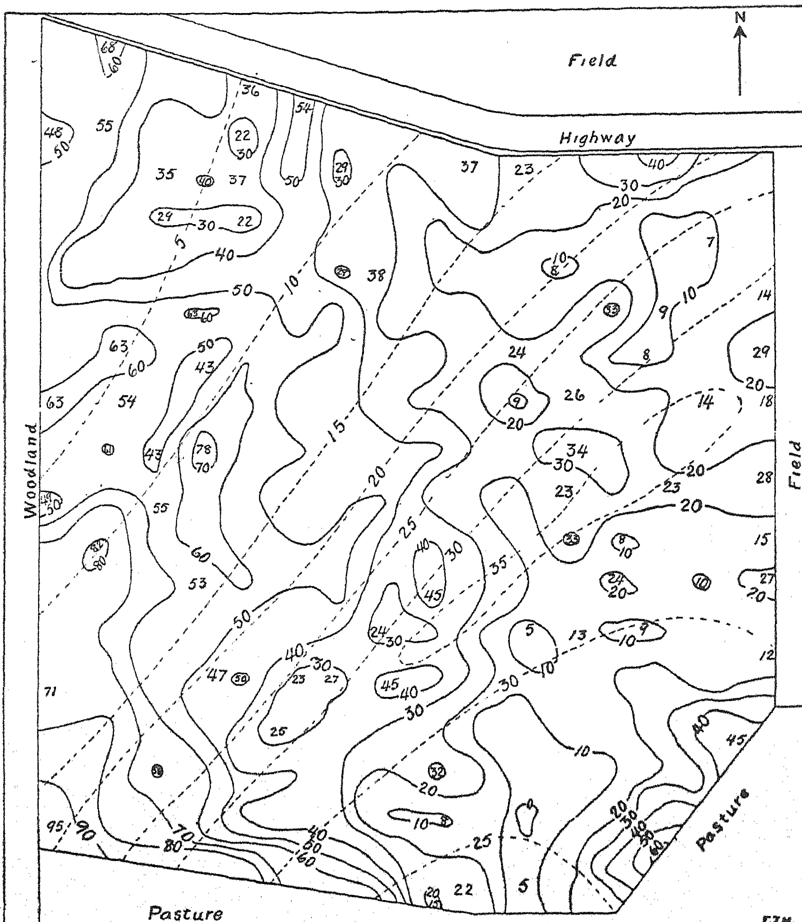

Fig. 2. Isofagal map showing the percentage of injury to grape buds by *Haltica chalybea*. Isofags shown by solid lines. Contours showing elevations in vineyard represented by broken lines.

possible, into squares containing 16 vines each (four vines on a side), calculated the average injury in each square and located this average at its center. With the elevation (percentage of injury) and location of each point on the map, the contour points were found by interpolation and the contour lines drawn. The result is shown in Figure 2.

We have also indicated the elevation of various parts of the vineyard by means of contours with broken lines.

From the map we note the following: (1) the distribution of injury is irregular; (2) the most extensive destruction of buds occurred in the southwestern portion of the vineyard; (3) the west side of the area was more severely injured than the east side; (4) the greatest variation in the percentage of injury was on the south side; (5) taking the vineyard as a whole, the edges show a higher destruction of buds than portions of the area slightly nearer the center; (6) peaks (portions having greater injury than the surrounding areas) and depressions without an outlet (portions having less injury than surrounding areas) are common. In this latter respect, our chart differs from the ordinary topographic map for, on land, depressions without an outlet are generally filled with water and therefore depressions with closed contours are seldom shown.

Regarding the causes of the infestation, we observe the following facts. The center of infestation was in waste land southwest of the vineyard. The beetles fly with the wind and are not active at temperatures below 55° F. and, on the days during May, 1914, when the temperature was above 55° the wind was from the south or southwest. In the vineyard, the movement of the beetles was in the direction of the prevailing wind on the warmer days. The beetles appear to be decidedly adverse to flying in any direction which has an angle of more than 45° to the direction of the prevailing wind. There appears to be no marked correlation between the topography of the vineyard and the distribution of insect injury, although it is to be noted that the infestation was light on the highest portion of the ridge. The woodland west of the vineyard shielded a portion of the area from the cold north and northwest winds, and, as the portion of the area nearest the forest was warmest, we believe the beetles were attracted to this section in greater numbers than elsewhere which accounts for the serious injury on this side of the vineyard. The increased injury near the northern and eastern edges may perhaps be explained by the fact that the vineyard was isolated and also that the beetles fly only from vine to vine. Hence, when they came to the edges of the vineyard, not finding vines beyond, they remained, and others continuing to arrive formed an accumulation of beetles which produced a greater percentage of injury than is found on the vines slightly farther removed from the edges of the vineyard.

A Cardboard Model

In an intricate chart like the one shown in Figure 2, it may be difficult to visualize the relative differences in elevation especially when peaks and closed depressions occur near each other. To overcome

this the writer suggests that a cardboard model be made by using the thickness of the cardboard to represent the contour interval. The outlines of the contours can be secured by placing carbon paper on the cardboard and underneath the map when the lines can be traced. The cardboard can then be cut with a sharp pointed knife and the portion which is lower than the elevation which the contour represents is removed. From these pieces the model can be built and the several parts glued together.

Advantages of Orthographic Projection

The chief advantages of this form of illustration may be summarized as follows:

1. The amount and location of the injury throughout the planting are clearly shown.

2. It permits the worker to use any degree of refinement and precision in the illustration of his problem and the data may be taken with this point in view.

3. When the data are plotted the chart assists in making proper deductions regarding the relationships between the distribution of the injury and the environmental factors.

4. If desired, the worker can use the data for the more exact but more laborious methods of biometrical analysis. Correlation coefficients and equations will give relationships in a quantitative form and can often be used supplementary to an orthographic chart. The point to be emphasized is that data taken accurately for this kind of chart can be used for more detailed analysis but the converse is not necessarily true.

5. This form of chart can be made with comparatively little extra study of principles and methods. In this respect, it surpasses biometrical analysis for the average worker, since the latter type of analysis requires a rather extensive ground work in mathematics, including calculus, theory of probability and least squares, before one can use the methods with facility and precision. It is true that one must master the principles of topographic surveying but these are not very difficult. The acquiring of speed and accuracy in field work will, however, require practice. To the worker who is not acquainted with the principles of topographic surveying, we would suggest that he first make a map of an area, in which the surface is sufficiently undulating to require considerable plotting to locate the contours. This preliminary exercise will assit him in plotting isofags where the positions of the contour points are not as obvious as in topographic surveying.

6. The chart, if not too intricate, is readily comprehended. Even an intricate chart presents the conditions throughout every portion of

the planting better than tables or any other form of graphical or pictorial representation known to the writer.

7. A solid model of the conditions represented in the chart may be made either for the purpose of teaching the principles involved or when the amount of detail tends to become confusing.

President R. A. Cooley: If there is no discussion, I will ask Mr. A. W. Morrill, Second Vice-President of the Association, to take the chair during the next number on the program, which is the discussion of the presidential address.

Vice-President A. W. Morrill: The next number on the program, as announced, is the discussion of the presidential address. I should be glad to hear from any one present.

Mr. H. A. Gossard: Mr. Chairman, I am quite sure that as a member of the Association I am indebted to the President for that very careful outline of the present situation. Doubtless every entomologist in the country has asked how he can best serve the country. We all ought to serve the country, and each one of us feels responsibility resting upon him in that service.

I am impressed with the remark that research is far ahead of knowledge. There is a vast mass of entomological information of which the farmer does not avail himself, and it is hardly available to him under our present organization.

The war is going to be very useful to us in developing an organization to carry this information to the people who need it most and for whom it was originally discovered. I find that our people are demanding entomological information. At the Ohio experiment station we have an editor of publications who keeps a tabulated record of the various papers, periodicals, etc., and makes use of our press bulletins and matter printed for general publication. We find that the press bulletins furnished by the Department of Entomology are more largely printed than those furnished by any other department. Our bulletins last summer were printed in seventy-seven different newspapers, were made use of by at least two press bureaus and other departmental stations had an equal record. We interpreted that as an indication that the public wanted information in regard to the saving of crops that they had already planted and brought to the point where they seemed to be ready to yield harvest and yet were frequently being snatched away at just the time when the farmer thought he had dollars in his pocket and food in the bin.

I am satisfied that we can work out extension programs that will be in demand and will be appreciated by our people.

I also appreciated very much the general discussion regarding coördinating the work over the country. We feel the need of that in our state and are getting matters adjusted just as fast as we can, but a great nation-wide coördinating bureau will mark a great advance in practical entomology, the kind that the farmer wants and the kind that he pays taxes for, and that he thought he was going to get when the experiment stations and the bureaus of entomology were established.

Mr. W. C. O'Kane: We are fortunate in having set before us at this time the keen and the valuable analysis that President Cooley has given in his address. I think it is never harmful to make changes, when those changes represent progress, and it doesn't make any difference what condition or circumstances gives rise to the changes; whether it be war or something else.

We have had brought home to all of us certain things that we can do, because the war has emphasized those things. President Cooley has analyzed the situation and has pointed the way. It is inevitable that practice should fall a little behind research, but it is our ambition to balance them so far as our human abilities will let us, and we know that we have a long way to travel in many of the problems.

A war brings many difficulties, but it brings privileges, and the entomologist who will rise to the opportunity presented by the present world situation will only be rising to a privilege.

Mr. S. J. Hunter: The President's address in a very timely and fitting way has presented to us the advantages at this time of coördination first, coöperation next, and personal contact last of all. Through the management and organization set forth there, we can get results which are comparable in the degree to which they are carried out. We have organization in other lines at the present time in this crisis. Why should we not have it in entomology?

The extent to which the President has outlined the degree to which this should be carried between the state and federal and the local authorities is along the lines of the highest efficiency, and I believe we will go away from here, each one of us in the work that is assigned in each one of our states, with a clear idea of the possibilities of carrying out to the fullest degree this line of organization.

Mr. S. A. Forbes: I was particularly interested and pleased with the President's address this morning because it makes quite unnecessary the little contribution which I had in mind to make in the discussion tomorrow forenoon: the fact that President Cooley said virtually everything I had in mind.

There is one thing, however, that I may add. We all appreciate the great privilege and opportunity which has come to us out of the desperate conditions growing out of the war; in the fact that we not

only are put upon our mettle to do the things that are required of us, but that we have the backing and assistance in every state in our country to help us do the things they want us to do. For example, in the state of Illinois the managers of the Associated Press and of the United Press Association came to me with requests for articles, just as many as I choose to put out, on any subject that I thought was pertinent and important, and they agreed to put those articles verbatim into every paper on their lists. The State Council for Defense makes the same proposition, and they have access to every paper published in the state, and so at every point if there is any agency that we can make use of, they are ready and willing to help us out. We have a chance to accomplish work and get standing with our communities and help the public and bring the matter to a practical phase of application, which we have never had before and the like of which we all hope we may never have again.

We have one feature of the situation in Illinois which I think you have reason to envy in view of the emergency which is upon us. At the session of the legislature last winter there was a law passed which gives the Director of Agriculture, known as the Commissioner of Agriculture in most states, the power to issue a proclamation, whenever an insect pest threatens serious injury either by multiplication or by spreading to territories not previously infested by it, and to make requirements upon the people by this proclamation to prescribe what they shall do and if they fail to carry out the requirements of the Director of Agriculture as thus publicly announced, they are subject to prosecution—they are guilty of a misdemeanor. We have the whole force of law behind any requirement which an emergency like this may call for. For example, in Illinois, the chinch-bug became quite a serious menace last spring. If, when the season opens next spring, it seems that that is a real serious emergency condition, we shall call upon the Director of Agriculture to issue a proclamation requiring those whose properties have been infested, to take certain precautions, and failing to do so they will be violating the law and subject to penalty. I think this is a step which most of the states have not yet taken.

Vice-President A. W. Morrill: Are there any further remarks? Before turning over the chair, I want to say that I think we are all agreed that the President could not have selected any more appropriate subject and that we all appreciate the very fine way in which he has handled the subject.

President R. A. Cooley: The next paper is entitled "The Life-History of the Strawberry Leaf-Roller," by Mr. Webster.

NOTES ON THE STRAWBERRY LEAF-ROLLER
(*Ancylis comptana* Fröhl.)

By R. L. Webster

This common insect has been most reported from states of the Mississippi Valley. Elsewhere in this country it has caused little notice. In the course of some work with this species in Iowa much new data were secured. A more complete account is to be published in a forthcoming bulletin from the Iowa Agricultural Experiment Station.

Most of the notes were taken at Ames in the last four years. W. O. Ellis and J. L. Horsfall have assisted the writer greatly in taking records and in making observations. These notes are from the files of the Entomology section, Iowa Agricultural Experiment Station at Ames.

Hibernation

Many contradictory statements have been made as to the manner in which this leaf-roller hibernates. For instance Riley (1869) stated that the insect hibernated as the pupa. Forbes (1884) said that the moths hibernated, appearing on the wing early in spring. Stedman (1901) makes the definite statement that the insects winter as larvæ in Missouri. Again M. H. Swenk (1908) says that the winter is spent as pupæ and J. B. Smith (1909) indicates that in New Jersey the winter is spent as pupæ. C. A. Hart (1911) states that it was determined that the larvæ hibernate in central Illinois.

The insect has been closely observed at Ames for several years, both in late fall and in early spring. Late in the fall (October), only larvæ were found. Again in early spring (March) only larvæ were present, pupæ not appearing until mid April. For central Iowa, at any rate, it is evident that the winter is spent as larvæ.

The Generations

Riley (1869) stated that two generations occurred in Missouri but Stedman (1901) indicated three. Garman (1890) showed that three generations occurred in Kentucky. Most writers have followed the old statement of Riley. M. H. Swenk (1908) gives three broods for Nebraska and C. A. Hart (1911) four in central Illinois.

The overwintering larvæ, which are nearly full grown, feed to some extent very early in spring but soon mature and transform to pupæ and later (in April) to adults. The moths deposit eggs and the leaf-rollers appear in late May and during June. This first brood frequently becomes very abundant and often causes severe damage to

strawberry foliage. A second generation appears late in June, and this is likely to last well through the month of July.

Again in August a third generation appears. This may be followed, in some years, by still another generation in September, making four generations. Our observations indicate that the fourth generation is not always complete and that, in some years at least, third generation larvæ spend the winter in strawberry foliage.

The most important facts from the study of the life-history are those bearing on the practical treatment. To be effective, spraying must be done early in the game, that is, before the larvæ have folded or rolled the leaves. After the leaf-rollers begin feeding and rolling leaves any treatment by spraying is largely ineffective.

The first chance for effective spraying is early in May. Arsenical spraying for strawberries, however, should be made previous to blossoming, since spraying while plants are in blossom would probably poison bees. Spraying at this time, that is, about the time the eggs are deposited, is essential to place the poison on foliage before the eggs hatch.

The Egg: Description

J. M. Stedman (1901) seems to have been the first one to observe the eggs and these were described by him, although no measurements were given. J. B. Smith (1909) also described the eggs and C. A. Hart (1911), working over notes made by J. J. Davis and the writer in Illinois in 1905 and 1906, gave a description and measurements.

The egg: Oval, varying greatly, much flattened: pale yellow-green, translucent. Surface pitted with numerous slight hexagonal depressions. Length .68 mm. Width .48 mm. (Average of 10 specimens deposited on foliage.)

Eggs deposited on the glass in insectary cages were quite uniform in shape; a true oval. The surface of the strawberry leaf with its fine hairs influences the shape of the egg on a leaf.

Place of Deposition

Stedman, Hart and J. B. Smith all state that the eggs are deposited on the under sides of the leaves. J. B. Smith stated that he had never seen an egg on the upper surface.

In field observations eggs were found placed on either surface and even on the stems. In the insectary cages, eggs were usually deposited on the upper leaf surface but frequently were placed on the inner surface of the glass chimney in which moths were confined. Field observations, in which counts were not made, indicate that on the whole the lower surface was preferred. The highest number of eggs found on a single strawberry leaf in the field was five.

Length of the Egg Stage

The length of the egg stage in spring and in summer varied. In the insectary in May, 1914, eggs hatched in 11.1 days, an average from 104 eggs, according to notes by the writer. In July and August, 1914, much less time was required; 115 eggs hatched in 5.5 days (average). The range was from 3 to 8 days.

In July and August, 1915, more time was required and an average of 8.5 days resulted in computing the data from 108 eggs. August, 1915 was the coolest August on record and July, 1915, with one exception, the coolest, so that the effect of temperature is clearly evident here. The range in 1915 was from 3 to 12 days.

On the contrary July, 1914 was, with one exception, the warmest July on record. Two extremes of temperature then have affected these records of the length of the egg stage.

Only one accurate record is available for July, 1916, when 21 eggs hatched in 5 days.

Number of Eggs Deposited by One Female

No one has previously given any records of the number of eggs deposited by a single female, so far as the writer is aware. Single pairs of moths were placed under large glass lantern globes which enclosed growing strawberry plants and daily records were made of all eggs deposited in the cages.

The records of 35 female moths indicate an average of 72.9 eggs per female. This average is undoubtedly low, because some moths died soon after being placed in the cage and consequently did not deposit a normal number of eggs.

The highest number of eggs deposited by one female was 136, according to a record by J. L. Horsfall in August, 1916. The lowest number was 12. In this last case the moth died the seventh day after being placed in the cage.

The Larval Stages

Newly hatched larvæ are about 1.5 mm. long. Four larval stages were determined by W. O. Ellis in the insectary in 1914. Single newly hatched larvæ were isolated in glass vials, fed on strawberry foliage, and the growth carefully observed from day to day.

Measurements of the head widths were made after each moult and recorded. From all the data accessible head width measurements of the four stages averaged as follows: Stage I, .22 mm.; Stage II, .33 mm.; Stage III, .59 mm.; Stage IV, .85 mm.

In 16 cases accurate records of the length of the entire larval stage, egg to the pupa, were secured. These averaged 19.8 days, from larvæ reared in July and August.

Variation in Color of Larvæ

Riley (1869) mentions a variation in color of larvæ from light yellowish brown to dark olive green or brown. Other writers have also mentioned this variation. This color appears to be seasonal in its occurrence, according to our observations in Iowa. During the greater part of the season the normal color is a yellow-brown. In September and October, as the cooler weather comes on, the larvæ assume a dull olivaceous color. In the fall both light and dark colored larvæ have been found at the same time. In spring the overwintering larvæ are dark in color, but the first generation from eggs are light.

Length of Pupa Stage

The pupa stage in summer is much shorter than in spring. From meagre data the length of this stage in April and May was found to be from 14 to 18 days. In the summer months an average of 6.4 days was spent as pupæ. This average is from 96 individual records in the years of 1914, 1915 and 1916.

Much difference in the time required was found in different years. Much longer time was required during the exceptionally cool summer of 1915, than in 1914 or 1916, when it was very hot. The length of the pupal stage was essentially the same for both sexes.

Length of Life of the Moths

Some data on the length of life of adult moths were secured in insectary cages, where individual pairs were confined for egg records. As a rule a little water sweetened with sugar was placed in these cages for food. In 1916 honey was substituted for sugar.

Twenty-four female moths lived on an average of 10.2 days, with a range of from 3 to 28 days. Nineteen male moths lived on an average of 10.1 days, with a range of from 3 to 23 days. It was thought that the males died more quickly in the cages than the females, but the average is too slight to consider of any importance.

In compiling these data only accurate records were used. In some cases moths were noted in the insectary experiments as having escaped. None of these records are used here, since the time of death of the insect was uncertain.

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PRESIDENT R. A. COOLEY: Do you wish to offer discussion on Mr. Webster's paper? If not, we will pass to a paper by Mr. Peterson, "Some Experiments on the Adult and Eggs of the Peach Borer."

SOME EXPERIMENTS ON THE ADULTS AND EGGS OF THE PEACH TREE BORER, SANNINOIDEA EXITIOSA SAY, AND OTHER NOTES

By ALVAH PETERSON, PH.D., *Assistant Entomologist, New Jersey Agricultural Experiment Station*

During the summer of 1917 a study was made of the peach tree borer at Mr. James M. Moon and Son's peach orchard near Clementon, N. J. This orchard has about eighty acres of seven- to eight-year-old peach trees of different varieties and for several years has been heavily infested with borers. The larger part of the orchard is on a light white sand soil and the smaller portion on a heavier gravel sand soil.

The majority of experiments were conducted under two large wire-screen cages located in the white sand portion of the orchard where the infestation was most severe. One all wire screen cage (12′ x 12′ x 9′)was constructed about a peach tree while a second wire-screen cage (8′ x 8′ x 6′) with a wooden roof covered with rubberoid was placed in an open space besides the large cage. These cages were built and put into position by Mr. J. B. Moon and Mr. Robert Schellenger and we are greatly indebted to them for their coöperation and the interest shown in this investigation. I am also indebted to Dr. T. J. Headlee for many valuable suggestions and the sincere interest shown.

The problem of the peach borer was approached from several aspects, but the principal lines of investigation were the food and feeding habits of the adults, the response of the female when ovipositing to various materials commonly used in spraying and other chemicals, the susceptibility of the eggs to certain contact insecticides and other compounds, and the effectiveness of certain mechanical protectors (Scott's tree protectors) and various chemicals (principally spray mixtures) in keeping the larvæ out of the tree. The last mentioned phase of the peach borer problem cannot be reported on at this time for it will be necessary to wait until the spring boring (1918) has been completed in order to obtain the desired data.

During the past season the adults emerged in the greatest number about the middle of August; a few were seen throughout the month of July and the last to emerge came out about September 15. Emergence occurred during the early hours of the morning (never after

9 a. m.) and copulation took place within one to twenty-four hours after coming out. No difficulty was experienced in getting captive males and females to copulate in captivity. This took place in the morning hours and usually ran from forty-five minutes to one and one-half hours. When through copulating, the female would start to deposit eggs in five to thirty minutes and continue this performance in the day time (9 a. m. to 4 p. m.) for forty-eight hours or even longer in some cases. The number of eggs deposited and possessed by different females varied considerably as seen in Table I.

TABLE I—NUMBER OF EGGS DEPOSITED AND THOSE IN ABDOMEN OF TEN FEMALES USED IN EXPERIMENTS

♀	Deposited	Abdomen	Total	♀	Deposited	Abdomen	Total
(1)	452,—74%	154,—26%	606	(6)	323,—75%	104,—25%	427
(2)	75,—39%	117,—61%	192	(7)	305,—66%	154,—34%	459
(3)	313,—70%	132,—30%	445	(8)	218,—34%	420,—66%	638
(4)	511,—73%	187,—27%	698	(9)	234,—63%	133,—37%	367
(5)	372,—69%	165,—31%	537	(10)	342,—69%	153,—31%	495

Average deposited was 314 or 64%, average remaining in abdomen was 170 or 36%, and average total was 484 Smallest number deposited was 75 and largest 511. Smallest female possessed 192 eggs and largest 698.

Many new and interesting facts have been observed in respect to the behavior of the adults but these will be omitted in this paper.

FOOD AND FEEDING HABITS

In respect to the food and feeding habits of the adult stage, it can be said that in all experiments and observations made under cages or throughout the orchard and in nearby woods no adult was ever seen to partake of or show any desire for food or liquid during its entire adult existence. Males and females would emerge from pupæ, copulate and then the female would proceed to deposit at least two-thirds the total number of eggs within her body and in the meantime show no desire for food. Anatomically the mouth-parts of the adult and their connection with the œsophagus seems to be normal and compares favorably with similar structures in adults of other species of the Lepidoptera that are known to feed.

The following chemicals were used in liquid form at varying dilutions in a number of experiments to tempt the adults to feed: corn syrup ("Karo," diluted one-half), cane sugar, honey, maltose, lactose, fructose, dextrine, acetic acid, ammonium hydroxide, pyridine, alcohol, formic acid, clove oil and distilled water. Fresh and decayed peaches and fresh peach gum were also used, but without success.

From the above results one can readily see the improbability of developing an attractive poison bait for the adult.

Repellents

When the female wishes to deposit her eggs she feels about the surface of the object on which she is located with the tip end of her abdomen. With this observation in mind it was thought that certain chemicals might repel her or at least keep her from depositing eggs on sprayed surfaces such as sprayed peach branches. Table II gives the results of a number of experiments with various spray mixtures. In each experiment one fertilized female was placed in a small round wire-screen cage (6 inches in diameter and 9 inches high) and two peach branches in an upright position (1 inch in diameter and 8 inches long), one sprayed and the other serving as a check. Light did not influence the female in depositing eggs for the position of the branches was reversed nearly every hour.

Table II—Repellent Effect of Sprays during Oviposition

Expt.	Spray	Check Branch	Sprayed Branch	Cage	Floor	Total
1	"Scalecide," 1-15	129	16	3	45	192
2	"Scalecide," 1-15	37	53	141	82	313
3	"Scalecide," 1-15	76	84	40	105	305
4	"Scalecide," 1-15 Carbolic, 1-99	211	42	44	24	321
5	Lime-sulphur, 1-9	163	86	196	7	452
6	Lime-sulphur, 1-9	80	6	130	96	372
7	Lime-sulphur, 1-9	25	8	0	0	33
8	Lime-sulphur, 1-9	103	53	72	6	234
9	Nicotine resinate, 1-100	93	66	20	0	179
10	Fish oil soap, 1-16	313	27	118	53	511
11	Fish oil soap, 1-16	133	15	48	127	323
12	Fish oil soap, 1-32	154	30	14	20	218
*13	Fish oil soap, 1-100 Carbolic acid, 1-99	20	18	0	11	49
14	Fish oil soap, 1-100 Carbolic acid, 1-99	24	31	17	3	75
15	"Fly-skat," 1-10	212	16	41	3	272
16	"Fly-skat," 1-10	160	25	174	133	492
17	"Fly-skat," 1-10	64	75	72	28	239
†18	"Fly-skat," 1-10	7	13	3	29	52

* Fly-skat is chiefly a creosote compound.
† Fertility of female questioned.

The results of the experiments recorded in Table II are not as definite as might be wished for; however, they do show the partial repellent effect of certain mixtures on the female during oviposition (Experiments 1, 4, 5, 10, and 15).

On August 21, one large experiment was set up in the large cage (8′ x 8′ x 6′) to determine the response of the female to various spray mixtures and this experiment ran continuously until September 21. Thirty-two peach branches, one to two inches in diameter and eighteen inches long, were cut on August 21 and sprayed; six with "Scalecide" (a miscible oil), 1–15 (Sc), four with "Fly Skat" (a creosote compound), 1–10 (Sk), six with lime-sulphur, 1–9 (LS), six with fish oil soap, 1 gr.–32 cc. (F), and ten checks (Ch) or unsprayed branches.

These branches were placed under a wooden frame (36″ x 18″ x 18″) covered with white mosquito netting and were arranged according to the following diagram. The branches on the outside rows and those at the ends stood upright while those on the inner row were tilted (45° angle) toward the middle and the opposite branches tied together at their tip ends. The letters in the diagram indicate the material used in treating and the number adjacent to the letters indicates the numbers of eggs on the respective branches. Ten tin cans (T.C.) were filled with moist sand and each possessed from 8–12 living pupæ in cases. These were placed in the center. This experiment ran for thirty days and in this period some sixty adults emerged and over 6,000 eggs were deposited by the females. The distribution of the eggs can be seen in the diagram and the average per branch in the table accompany the diagram.

Diagram Showing Arrangement of Sprayed and Unsprayed Branches and the Number of Eggs Deposited on the Respective Branches. The Top Margin of the Experiment Faced the North

Ch/525	76/Sk	F/203	101/Ch	LS/234	118/Sc	Ch/342	51/Sc	LS/182	91/Ch	F/245	31/Sk	Ch/540
Sc/256												180/Sc
		T.C.		T.C.		T.C.		T.C.		T.C.		
LS/175												170/LS
		T.C.		T.C.		T.C.		T.C.		T.C.		
Sc/235												111/Sc
685/Ch	Sk/22	108/F	Ch/164	72/LS	F/83	176/Ch	F/176	95/LS	Ch/118	126/F	Sk/36	261/Ch

Average Number of Eggs per Branch Receiving Similar Treatment

Spray	Average Number of Eggs on Branches		
	Upright	Tilted	Total Av.
Ch,—Check branches	421	116	300
F,—Fish oil soap	170	129	156
LS,—Lime sulphur	154	...	154
Sc,—"Scalecide"	195	84	158
Sk,—"Fly-skat" (Creosote)	...	41	41

The above experiment and the experiments with individual females (Table II) show the partial repellent effect of certain materials on the female when ovipositing. In a number of cases the repellent served to cut down the number of eggs 50 per cent and in some instances the reduction was below this, but no material completely repelled the female. How females would respond to these mixtures in the orchard has not been determined, but so far as we know they would behave in a similar manner. Since the above sprays will not repel the female in captivity, it is inadvisable to make use of these materials in the orchard with the purpose of repelling the female.

One interesting point in the above experiments is the location of the eggs of the peach borer. The female usually deposits eggs on peach trees only, but in the above experiments the eggs were deposited to some extent on the cage and floor of the cage. This indicates that the female does not always deposit eggs on peach trees which agrees with observations made by various investigators.

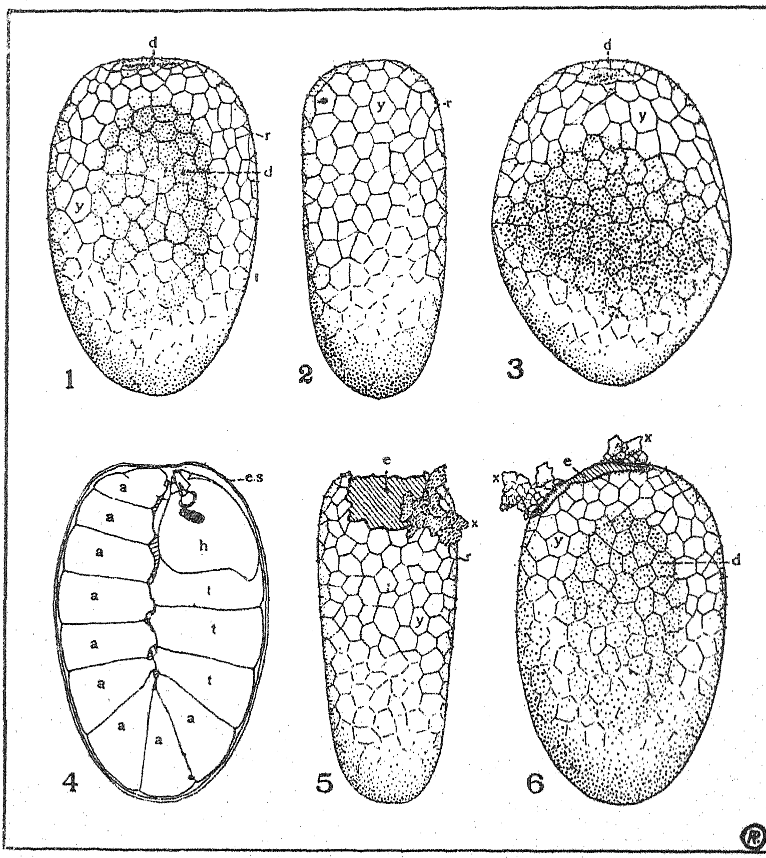


Fig. 3. See text for explanation.

Eggs

The egg of the peach borer is a small flattened ellipsoidal body with one end broader (more obtuse) than the other (Fig. 3, 1 and 2). The egg averages .65 mm. (1/40 of an inch) in length and .4 mm. (1/60 of an inch) at its greatest width. The two broad surfaces of the egg are flattened and slightly concave (d) and one of these surfaces is adjacent to the object on which the egg is deposited. The egg has a soft chest-

nut brown color and possesses distinct hexagonal and variously shaped areas (y) on the surface. These areas are marked off by elevated light colored lines (r) and are most prominent toward the large end of the egg.

A distinct larva (Fig. 3, 4) may be found in a U-shape position within the egg two or three days before hatching; the head and caudal portions located near the large end of the egg. When the larva is ready to emerge it breaks through the thin depressed area (d) at the large end of the egg. It punctures the shell with its mandibles and then continues to tear down the egg shell (e. s.) ventrad of the head until the opening (e) is large enough for it to crawl out (Fig. 3, 5 and 6). The bits or fragments (x) of the egg shell torn off by the mandibles of the larva are not consumed, but shoved to one side.

The eggs of the peach borer require from 9 to 11 days to hatch, but in a few cases it took a day or two longer. From 90 to 100 per cent of the fertilized eggs hatched in the checks used in the various experiments while eggs deposited by unfertilized females never hatched. When eggs were deposited on sprayed branches, the spray never affected their hatching.

A few experiments were conducted with the eggs. They were sprayed with various chemicals, principally common contact insecticides and the effect of these on the eggs is shown in Table III. Eggs which did not hatch usually collapsed as in Figure 3, 3 this was particularly true of eggs killed by "Scalecide" (a miscible oil) and "Fly-skat" (a creosote compound). All eggs were sprayed within five days after they were deposited.

In the following experiments no material was sufficiently effective to consistently kill 100 per cent of the eggs or enough to make any one material worthy of being considered an infallible agent in killing peach borer eggs. "Scalecide," a miscible oil, at varying strengths gave the best results, killing 40 per cent to 100 per cent of the eggs in the different trials (Experiments 1–6) and the stronger concentrations were the most effective. "Scalecide" combined with crude carbolic (Experiments 5 and 6) was given two trials. "Fly-skat," 1–10 (largely a creosote compound) was given several trials and the results vary somewhat. In Experiment 8 (no check) two eggs failed to hatch out of 47 while in Experiments 7 and 9 about 66 per cent of the eggs were killed. A few experiments were conducted with fish oil soap alone, fish oil soap and crude carbolic, and laundry soap and cresol, but these are not extensive enough to base any conclusions on them. Lime-sulphur, 1–9, was tried (Experiments 13 and 14) and 30 per cent were killed in experiment 13. Nicotine resinate was given a number of trials (Experiments 15 to 19) at varying strengths (1–100, 1–250,

Table III—Table Showing Effect of Sprays on Eggs

Expt.	Spray	Total Eggs	Eggs Hatched	Eggs Dead
1	"Scalecide," 1–15	44	0	44
1	Check	29	27	2
2	"Scalecide," 1–10	104	24	80
2	Check	29	27	2
3	"Scalecide," 1–20	102	28	74
3	Check	15	13	2
4	"Scalecide," 1–30	103	43	60
4	Check	11	11	0
5	"Scalecide," 1–15 plus Carbolic, 1–99	41	0	41
5	Check	29	27	2
6	"Scalecide," 1–20 plus Crude carbolic, 1–99	40	7	33
6	Check	93	93	0
7	"Fly-skat," 1–10	45	15	30
7	Check	44	44	0
8	"Fly-skat," 1–10	47	45	2
9	"Fly-skat," 1–9	57	19	38
9	Check	16	15	1
10	Laundry soap, 1–200	60	54	6
10	Check	31	28	3
11	Fish oil soap, 1–10	57	2	55
11	Check	34	34	0
12	Fish oil soap, 1–10 Crude carbolic, 2–99	61	0	61
12	Check	33	33	0
13	Lime-sulphur, 1–9	36	23	13
13	Check	29	27	2
14	Lime-sulphur, 1–9	42	32	10
14	Check	53	44	9
15	Nicotine resinate, 1–100	41	40	1
15	Check	29	27	2
16	Nicotine resinate, 1–100	64	61	3
16	Check	28	24	4
17	Nicotine resinate, 1–100	30	29	1
17	Check	31	28	3
18	Nicotine resinate, 1–250	102	100	2
18	Check	11	11	0
19	Nicotine resinate, 1–500	82	82	0
19	Check	59	57	2

and 1–500), yet in no experiment was there a sufficient number of eggs killed to warrant the statement that this material might kill eggs. It was thought, when the material was used, that it might act as a stomach poison and kill the larva as it ate (apparently) its way out of the shell, but as pointed out before the larva probably does not consume any considerable portion of the shell as it breaks through with its mandibles. Nicotine resinate has good lasting qualities and is not readily decomposed after spraying, consequently, any larva which consumes its shell would suffer if nicotine resinate were present.

The lasting effect of nicotine resinate is shown in one experiment where on July 16 the lower portions of fifteen seven-year-old peach trees were sprayed with two and one-half gallons of nicotine resinate, 1–100 (one gallon for six trees). Small pieces of bark were removed on July 23, July 30, August 4, August 13 and August 21 from the trees which only received one treatment, and placed in a clean test tube with a small amount of distilled water and shaken. After standing for about 30 minutes the solution was filtered and a few drops of silicotungstic acid solution were added to the clear filtrate. Immediately the solution became cloudy having the appearance of a white milky solution. Bits of bark removed from unsprayed check trees were also tested each time and in all cases the filtrate remained clear. The sprayed trees were tested again on September 21, but at this time there was no indication of nicotine. The above qualitative test for nicotine is recommended by Mr. V. I. Safro. (See, "How to Test for the Presence of Nicotine on Sprayed Plants," Journ. of Econ. Ent., 1917, vol. 10, pp. 459–461.) The above experiment shows a definite test for nicotine on the bark of peach trees five weeks after application of nicotine resinate, 1–100. It should also be noted that a number of heavy rains occurred between July 16 and August 21.

Summary

The results in the above experiments are largely negative, so far as they may help to develop a much needed control measure for the peach tree borer. In brief they show the improbability of developing a poison bait for the adult, the partial repellent effect of certain chemicals on the female while ovipositing and the partial destruction of eggs when certain substances are applied as a spray. A number of experiments have been started and are now in operation on the use of various chemical and mechanical tree protectors but the evidence obtained thus far is insufficient to warrant a statement at this time. The author is of the opinion that the peach borer problem will be solved when some mechanical or chemical barrier is found which will kill the larva before it enters the tree or prevent it from getting into the tree. The development of any control measure along the line of killing the larva after it enters the tree is not advisable.

President R. A. Cooley: Mr. Peterson's interesting paper is before you for discussion.

Secretary A. F. Burgess: I notice on the program that in Mr. Peterson's summary he made note of the use of tree protectors. I wonder if he has any information on that subject that he didn't give in his paper.

Mr. Alvah Peterson: In the last statement made on the use of various chemicals and mechanical barriers against the young borers, it was said that up to date we haven't sufficient data to give any conclusive facts in regard to the use of tree protectors. We put on one hundred Scott tree protectors and also sprayed a number of trees with various chemicals and insecticides such as fish oil soap, nicotine resinate, "scalecide," crude phenol, etc. During the past season, the adults came out late compared with records of former years. In New Jersey, the greatest emergence occurred about the 20th of August. This late emergence gave the majority of the larvæ only a short time in which to grow before winter set in, consequently we found that the larvæ were very small when we bored the trees about the 15th of November. In boring we found no small larvæ under the tree protectors, but I am not sure that this will be the condition when we bore again next spring. In using tree protectors, we not only sealed them with asphalt and some with borene, but we also made use of a strong paper clip which was slipped over the tarred paper where the two margins overlapped. This helped to hold the protector in position while the asphalt or borene sealed the openings. Where paper clips were used, it was only necessary to reseal the protectors once about 30 days after they were put on and at this time only 50 per cent of them showed any cracking or splitting. The above does not agree with our former experience with tree protectors where we resealed several times. Undoubtedly the paper clip is an important additional feature.

Since we are still experimenting with tree protectors, I am not willing to go on record as saying that the tree protector is going to eradicate the larvæ, but so far as the present evidence is concerned it looks favorable.

Mr. J. L. King: Mr. Peterson's remarks concerning the tree protector as a control of peach tree borers are very interesting to me. His results are more encouraging than my first experiments were. While an assistant in the Ohio Experiment Station in 1916 we conducted a test of 70 tree protectors at Gypsum, Ohio.

The first orchard used was about seven years old, and was seriously infested with Sanninoidea larvæ, which averaged 7 per tree, with an 100 per cent infestation in the check trees. In this orchard 50 protectors were placed about June 15. One-half of these were sealed with tar and the remainder with tree tanglefoot. The protectors were resealed three times during the egg-laying season (July 5 to September 5). At the close of the season the trees were examined for borers. The infestation was 100 per cent, and the average number of larvæ per tree was 5.

In the second orchard a plot of 20 trees was used. These were 7

years old. Twenty tree protectors were placed about the trees in mid June, and resealed, as in the first plot. At the close of the season they were examined for borers. The per cent of infestation was 30, as compared to 40 per cent in the check plot. In this second plot a number of large ant nests were found under the protectors, which served as ideal places under which to build their nests.

Perhaps the failure of the tree protectors in this case may be explained by the fact that the high winds sweeping over Lake Erie and Sandusky Bay sway the trees to such an extent that it is very difficult to keep the protectors tightly sealed for any length of time.

PRESIDENT R. A. COOLEY: Is there any further discussion on this paper? If not, I will call for the next paper, "The Apple Ermine Moth in New York," by Mr. Parrott, of Geneva, N. Y.

This paper will be presented by Mr. Fulton.

THE APPLE ERMINE MOTH

By P. J. PARROTT, *New York Agricultural Experiment Station*

In the JOURNAL OF ECONOMIC ENTOMOLOGY, vol. 3, p. 157, a brief account was given of the occurrence of the cherry ermine moth (*Yponomeuta padellus* L.) on imported cherry seedlings. Since the publication of this article an associated species has been observed on apple, and it is desired at this time to place on record some notes relative to its identity and distribution in nurseries and orchards.

Of the various species of insects imported from Europe on apple seedlings no other is more persistent or occurs in such large numbers as the ermine moth. Since our attention was attracted to it in 1910, no year has passed that the horticultural inspectors have not discovered colonies of caterpillars in plantings of foreign stocks. Moreover, recent years have witnessed greatly increased numbers of the insects. During 1915 and 1916 approximately 4,223 infested plants were discovered, while during 1917 all previous records were exceeded as 13,674 seedlings infested with caterpillars were discovered and destroyed. In view of the experiences in New York it is a significant fact that neither this species nor the associated form have so far been reported from any other state. The only area on the American continent outside of the state of New York from which the insect has been reported is New Brunswick where, according to Dr. Hewitt, it was found necessary to destroy 450 imported apple seedlings because of the presence of egg masses.

Aside from the increased abundance of the insects in foreign importations, we have also to record the discovery of the pest in three bear-

ing orchards in the region of Seneca Castle, by Messrs. Maney and Rupert, Horticultural Inspectors of the State Department of Agriculture. The orchards were in the immediate vicinity of nursery plantations, and the infestation of the trees unquestionably occurred during 1916, when moths originating from eggs on imported apple seedlings sought neighboring orchards for purposes of oviposition. Notwithstanding the presence of other kinds of fruit, the infestation was entirely confined to apple trees.

The occurrence of the insect on apple and not on cherry raises the question to which species it belongs,—to *padellus* or *malinellus?* As we have previously pointed out, the moths of the former species are exceedingly variable in their markings, and unfortunately the identification of the two species seems to rest largely upon color distinction of the adult insects. In spite of seeming morphological and biologic differences, the separation of these insects is difficult and unsatisfactory; and there exists consequently considerable uncertainty as to the actual status of these two forms. The adults of *padellus* reared from cherry and hawthorn particularly, and of *malinellus* from apple represent for the most part extremes in wing coloration. The former contains a majority of moths which have the primaries and fringes clouded, greyish or lead colored, while the latter has a majority of moths with primaries and fringes white. The two are distinct enough when characteristic examples are selected, but the separation of them becomes difficult when the intergrading forms are considered, as they merge into each other by imperceptible gradations.

In order that the moths recently bred from apples should be correctly identified, specimens were forwarded to Dr. Paul Marchal, Paris, who has devoted considerable attention to these insects, and in a letter dated October 20, 1917, he reports as follows: "The *Hyponomeutas* which you forwarded to me have arrived. They were in rather bad condition as the wings of two specimens were detached; however they agree well with the species *H. malinellus*. They are distinguishable from *padellus* by the front wings, the ground color of which is white, while the margins, examined from below, are finely bordered with white. The fringe of the anterior wings is also mostly white, and not grey as with *padellus*. Although the moths are considered distinct species I am not at all certain but that under certain conditions one form may produce the other. It cannot be positively denied that they are not two varieties of the same species."

Breeding experiments are needed to definitely settle the status of the two moths, but until these are undertaken the example of European writers may well be followed of designating the insects bred on hawthorn and cherry as *padellus* and those from apple as *malinellus*.

President R. A. Cooley: We will pass to the next paper by Mr. Garman.

NOTES ON THE LIFE-HISTORY OF LASPYRESIA MOLESTA BUSCK

By Philip Garman, *College Park, Md.*

(Withdrawn for publication elsewhere)

President R. A. Cooley: If there is no discussion we will pass to the next paper on the program, "The Calcium Arsenates and Their Efficiency as Insecticides," by Mr. Lovett, of Oregon.

THE CALCIUM ARSENATES

By A. L. Lovett, *Entomologist, Oregon Agricultural Experiment Station*

Introduction

The value of the lead arsenates as a stomach poison for insects has been thoroughly established for the past two decades. Just now the general advance in price on all commodities due to the war conditions has affected this material as well and the report is current that the available supply of lead arsenate is limited. This condition makes necessary the development of an efficient and practical substitute.

Calcium arsenate has long been recognized as a cheaper material than the lead arsenate, but though numerous sporadic tests have been undertaken the general conclusion has been that the material is unsatisfactory because of too frequent excessive burning. The prevailing conditions have revived the interest in calcium arsenate and a number of investigators, including ourselves, have begun a study of these materials.

One of the larger commercial spray manufacturing companies estimates the annual production of lead arsenate for spray purposes at 30,000,000 pounds. This makes the annual cost to the grower about $3,600,000 for their poison spray. Calcium arsenate, in which the comparatively cheap lime is substituted for the expensive lead, can be obtained at one-half the cost of the lead arsenate or effect a saving of $1,800,000 annually. This estimate is based on pre-war prices and the difference in favor of the calcium arsenate should be even greater now.

An analysis of commercial samples of calcium arsenate gave a very high water soluble arsenic content, and as with most arsenical sprays the cause of burning is largely due to the action of the arsenic on the

foliage. This same difficulty was encountered in the earlier attempts to use lead arsenate and it was therefore assumed that, as with the latter, a more complete knowledge of the properties of calcium arsenate, its composition and preparation, might lead to some practical method for its substitution for the more expensive lead arsenates.

The calcium arsenates which would prove of any practical interest from an insecticidal point of view must have certain physical and chemical properties, including a reasonable stability. A study of the commercial calcium arsenates, including some supposedly high grade c.p. salts intended for reagents, indicated that without exception they were mixtures of two or more calcium salts, no two of which were alike in composition.

Believing that the only possible method to properly study the properties of the calcium arsenates for the purpose of determining their value as an insecticide and to establish any reliable data from which sound conclusions may be drawn as a basis for future work is to prepare the pure salts, this study was first undertaken.

Calcium Arsenates Prepared

The chemical work in connection with this project was outlined and developed in its entirety by Mr. R. H. Robinson, Assistant Chemist at the Oregon Station, and a manuscript detailing the work and results has been submitted to the *Journal of Agricultural Research*. This will be published probably in April and to comply with the spirit and letter of the regulations concerning matters submitted there, an attempt will be made simply to summarize some of the essential details of this work.

Two calcium salts, the acid calcium arsenate and the neutral or basic calcium arsenate, known respectively as $CaHAsO_4$ and $Ca_3(AsO_4)^2$ were prepared in the pure form, both of which give much promise as insecticides. The chemical and physical properties of the two salts, including the specific gravity, solubility and relative stability were determined. The specific gravity and fineness of division, physical properties so essential in a powdered spray to permit of the efficient spread on foliage and a suspension for a reasonable time in solution, were found to be satisfactory. Both materials when subjected to severe tests were found to be somewhat soluble. The calcium hydrogen or acid arsenate is decidedly soluble, approximating the amount shown by field tests to cause serious burning and indicating that this salt should not be used alone as a spray. The tricalcium, neutral or basic arsenate is only slightly soluble and would appear to be a safe spray material to use alone. From the standpoint of stability, the basic arsenate again showed to an advantage while the acid arsenate proved very unstable, permitting the formation of harmful amounts of soluble arsenic.

Excess Lime or Lime-Sulphur Render Materials Safe

Considered from a practical standpoint it is evident that if some substance could be added to the spray which would prevent solubility and reactivity it would prove beneficial in the use of neutral calcium arsenate, $Ca_3(AsO_4)^2$, and absolutely essential if acid calcium arsenate, $CaHAsO_4$, were to be rendered safe as a spray solution. Ordinary quicklime, CaO, should fulfill the requirements, the $Ca(OH)^2$ becoming soluble reacting with any arsenic going into solution forming more calcium arsenate. As with the previous cases this proposition was subjected to a variety of elaborate chemical tests and the conclusion, following a careful analysis of the results, is that wherever CaO is present in even slight excess so that $Ca(OH)^2$ may be found qualitatively in solution, no soluble arsenic will occur. One precaution must be observed here; be sure the lime is CaO and not $CaCO_3$ as this latter material reacts very slowly with the calcium salts and does not prevent the formation of soluble arsenic. If one part of CaO is added for an equal amount of either acid or basic calcium arsenate in the solution, no burning of foliage should result from the spray due to the formation of soluble arsenates.

Because of the desirability of combination sprays, studies of the calcium arsenate-lime-sulphur mixture were undertaken. Following the reports of G. E. Sanders (1) as included in the proceeding of the Entomology Society of Nova Scotia for 1916 and in communications from him on the success of the calcium arsenate-lime sulphur combination under field tests, more elaborate experiments with the pure materials in dilute lime-sulphur solutions were conducted.

The tests were in all cases favorable beyond expectation. In addition to the pure salts, commercial calcium arsenates consisting of a mixture of $CaHAsO_4$, $Ca_3(AsO_4)^2$, $CaCO_3$ and other materials were tested with the lime-sulphur. With all the materials no chemical reaction occurred and all the constituents remained constant. These tests included samples of the dry lime-sulphur now on the market which likewise was apparently a safe combination. A careful review of the article by W. M. Scott (2) on arsenate of lime would indicate that the absence or presence of lime-sulphur in the solution was correlated with the presence or absence of burn.

Analyzed for total arsenic it was found that the calcium salts contain more than twice as much of the active killing agent as do the corresponding pure lead salts. Theoretically then for spraying purposes only one-half as much calcium arsenate is required as of the lead arsenate. This point requires more elaborate experimentation. Preliminary laboratory tests with sprayed foliage, using a total of 50 tent caterpillars for each spray, indicated a very high toxicity, particularly for the

3. Scott & Siegler. 1915. Misc. Insecticide Investigations, U.S.D.A. Bul. 278, p. 47.
4. Lovett & Robinson. 1917. Toxic Values and Killing Efficiency of the Arsenates. Jour. Agric. Research, X, No. 4, p. 199.
5. DeSellem, F. E. 1916. Calcium Arsenate. Ann. Rept. Hort. Dept., 1916, Yakima Co., Wn., p. 45.

President R. A. Cooley: This interesting paper is before you for discussion. Studies of the effectiveness, burning qualities and cost of arsenicals are important, and it is evident that much is left which we might desire in our knowledge of these matters. In Montana, a plant pathologist has for years been studying effects of arsenicals mainly on the apple and has shown, as was published in the *Journal of Agricultural Research*, in his experiment that white arsenic was remarkably non-injurious to the foliage of the apple when sprayed on the trees. Following this, we recently attempted to use white arsenic in spraying potatoes, receiving no injury whatever on the potatoes, when amounts comparable to the amount of arsenic in Paris green were used, and surprisingly not killing the potato beetle, *Leptinotarsa* 10-*lineata*. We have evidently some things yet to learn about arsenicals.

The next paper is "The Influence of Molasses on the Adhesion of Arsenate of Lead," by Mr. Hartzell, of New York.

THE INFLUENCE OF MOLASSES ON THE ADHESIVENESS OF ARSENATE OF LEAD

By F. Z. Hartzell, *Vineyard Laboratory, New York Agricultural Experiment Station, Fredonia, N. Y.*

The use of molasses in spraying mixtures, for various reasons, has been recommended by certain workers in plant pathology and entomology. During the period from 1910 to 1916 the writer used molasses to make arsenate of lead more attractive to the Rose Chafer (*Macrodactylus subspinosus*) and the grape root-worm (*Fidia viticida*). The success that attended these earlier experiments we believe to have been due to the lack of rain in the period immediately following the application of the material. During 1912, the observations in vineyards sprayed with this combination indicated that failures to secure favorable results against the grape root-worm that season were related to the number of days intervening between the time of spraying and the first rain; *i. e.*, the shorter the time the less perfect the control of the insect. This in turn suggested that the adhesiveness of

sprays might be an important problem to be investigated. It was believed that ordinary foliage tests for adhesiveness were unreliable because of the difficulty of securing quantitative data. To overcome this difficulty the writer devised the following method for making tests of adhesiveness in the laboratory where the various factors might be under control.

Method and Apparatus

The gelatin film which had served as photographic negatives on 5 x 7 glass plates was removed by means of hot water and the glass arefully cleaned by immersion in a sulphuric acid-potassium permanganate bath. Afterwards the plate was washed in hot water and soap and then rinsed in clean water. Between thirty and forty plates were generally used in each series of tests when they were recleaned and used again. Each plate was numbered by means of a series of notches in one edge with a file. This system can be modified by numbering the glasses with diamond ink. In either method the marks are made on an edge or on the surface of the back of the plate. Before a test each plate was weighed on a balance sensitive to one-tenth of a milligram.

The brands of arsenate of lead to be tested were used at the rate of one gram of paste arsenate of lead or .5 gram of dry lead to each 100 cc. of distilled water. The samples requiring molasses had the same amount of arsenate of lead to which was added 2 cc. of molasses to each 100 cc. of water. When the sample was prepared it was carefully stirred to place all material in suspension and 10 cc. of the mixture was removed from the flask by means of a pipette and poured upon the plate, care being taken to spread the material uniformly over the surface. The plate was then placed in a horizontal position and allowed to dry at room temperature (near 68° F.) for twenty-four hours, when it was reweighed. Each plate then received a drenching with ordinary tap water delivered by means of a sprinkling arrangement (described below) whereby the treatment was uniform. They were then placed in a vertical position on a drying rack and allowed to dry for twenty-four hours and, at the expiration of this time, were reweighed.

The washing outfit consisted of a receptacle holding 3.25 gallons of water, tapering to an ordinary shut-off to which a rose sprinkler was attached. This water container was suspended by means of a wire. The distance from the sprinkler to the plates was exactly two feet. Two plates were placed horizontally on a holder in a sink; the water turned on and allowed to flow until the receptacle was empty, which required exactly two minutes. Of course all the water did not strike

the plates but it was found that two plates could be treated at one time with the same precision as one. During the washing the outfit was swung slightly so as to distribute the water equally to all parts of the plates. The temperature of the water was recorded before each washing. In fact every effort was made to have all tests uniform that the various brands or combinations tested in the several series could be compared. Each brand or combination was tested by treating from two to five plates identically.

We first attempted to spray the mixtures on the plates but found it difficult to apply comparable amounts of material. The question of drying the plates was most perplexing. We first tried drying them in a water jacketed oven, regulated by a thermostat but found this method unsatisfactory. All the plates did not receive the same amount of heat so the upper and lower ones dried first and also there was not the proper air currents to carry off the moisture. This obstacle can be overcome only by means of a change of apparatus, entailing considerable expense so has not been attempted. We might add that drying at room temperature yields fairly accurate results.

Ground glass plates have been substituted for the ordinary ones, thereby simulating, it is believed, the more or less corrugated surface of the leaf but these have shown little advantage over the smooth plates. Glass has been used in all these experiments because of the necessity of using chemicals to thoroughly cleanse the plates before and after each test. It is true that these results are not identical with tests on foliage but they give us a method of comparing the adhesiveness of various substances under identical conditions.

Experimental Results

During the winter of 1912–1913, about 500 tests were made with different brands of arsenate of lead and other insecticides to determine their sticking properties either alone or with other materials. As many of the experiments were conducted with the aim of finding mixtures that would be both attractive and also possess adhesion and since this work is still in progress we will confine our remarks to characteristic tests with arsenate of lead used alone and with molasses. These data are set forth in the following table.

Before discussing this table, we would state that the several plates treated identically in each series gave amounts of material retained that were fairly uniform, so no serious error is introduced by using averages.

From this table we note (1) that the percentage of material remaining on the plates after sprinkling differs considerably with the different

Table Giving Data of Adhesive Tests

Material Applied to Plates	Average Amount of Material on Plates after Drying 24 Hours and before Sprinkling, Grams	Average Amount of Material on Plates after Sprinkling and Later Drying for 24 Hours, Grams	Per cent of Material Remaining on Plates	Number of Plates Used
Brand A, a paste arsenate of lead without molasses	.0587	.0017	2.9	5
Brand A with molasses	.2632	.0012	*2.0	5
Brand B, a paste arsenate of lead without molasses	.0424	.0024	5.7	5
Brand B with molasses	.1452	.0002	* .5	5
Brand C, a paste arsenate of lead without molasses	.0580	.0509	87.8	5
Brand C with molasses	.1611	.0158	*27.2	5
Brand D, a paste arsenate of lead without molasses	.0353	.0140	39.6	3
Brand D with molasses	.1426	.0046	*13.0	3
Brand E, a dry arsenate of lead without molasses	.0479	.0039	8.1	2
Brand E with molasses	.1814	.0047	*9.8	2
Brand F, a dry arsenate of lead without molasses	.0707	.0079	11.2	2
Brand F with molasses	.2070	.0045	*6.4	2
Brand G, a paste arsenate of lead without sugar	.0546	.0089	16.3	3
Brand G with cane sugar	.1564	.0016	*2.9	2
Brand H, a commercial preparation of Bordeaux and lead without molasses	.0501	.0438	87.4	5
Brand H with molasses	.1840	.0016	*3.2	5

*In the tests in which molasses was added we have assumed that the same amount of insecticide was added that was found on the plate of the same brand without molasses and have calculated the percentage retained using this amount as the base.

brands of leads; (2) no dry arsenate of lead proved as adhesive as the better adhering paste arsenate of leads; (3) several of the brands of paste arsenate of lead had poorer adhesive qualities than the brands of dry arsenate of lead tested; (4) in every instance, save one, the addition of molasses to an arsenate of lead lessened its adhesive properties and this decrease in sticking power was greater in some brands than in others; (5) molasses greatly decreased the adhesiveness of a commercial preparation of Bordeaux mixture and arsenate of lead; and (6) cane sugar used in practically the same amount as contained in molasses caused marked lack of adhesiveness in arsenate of lead and therefore we believe that the sugar contained in the molasses is largely responsible for the decreased power of adhesion.

The results just given are of a preliminary nature and further investigation of this problem is planned. However, it is worthy of note that when the same combinations were tested on grape foliage during the period from 1913 to 1916 it was found that any brand of arsenate of lead which showed poor adhesiveness in the laboratory tests also proved to adhere poorly to grape foliage. It was not possible, however, to determine these variations on the leaves with as high a degree of precision as in the laboratory.

Having determined the above facts we were able to secure excellent results with molasses and arsenate of lead for the control of the grape

root-worm by studying the weather indications and applying the spray at a time when there was little probability of rain and also following the first spraying in about one week with an application of Bordeaux mixture and arsenate of lead to act as a repellent to invading beetles which might enter the vineyard during the dispersion period. We therefore suggest that the weather conditions be observed and care exercised to apply the molasses and arsenate of lead mixture at such a time when freedom from rain is to be expected for at least three or four days.

PRESIDENT R. A. COOLEY: Do you wish to ask Mr. Hartzell any questions or to discuss his paper? If not, we will pass to another paper by Mr. Lovett, "Spreaders for Arsenate Sprays."

SPREADERS FOR ARSENATE SPRAYS

By A. L. LOVETT, *Entomologist, Oregon Agricultural Experiment Station*

The economy of orchard spraying practices is a vital problem today and probably more acute in the northwest than elsewhere. This is due in part to our mild climate, our excessive moisture conditions in the spring and to the narrow margin between profit and loss, requiring a very high percentage of perfect fruit if our crop is to bring returns.

This problem of economics has made necessary a very intensive study of spray materials at the Oregon Station, their combination, relative value and frequency of application and has resulted in a series of papers touching on this question.

The results of the past three seasons as reported by Tartar and Wilson (1) and Lovett and Robinson (2) on the Toxic Values of the Arsenates has lead to the conclusion that we are using our arsenates of lead in more concentrated form than is necessary. Our laboratory experiments indicate that approximately as great efficiency is obtained with acid lead arsenate at a dilution of 1–400 as at 2–50. Allowing for the natural factors which make it impossible to achieve ideal results under field conditions, theoretically a strength of 1 pound of arsenate to 100 gallons of water should give efficient control. In spite of this our growers feel that sufficient additional protection is obtained with the July and August applications for codling moth as to warrant the additional expense of using 3½ pounds to 50 gallons.

A careful analysis of this condition warrants the contention that this apparent discrepancy is due largely to indifferent methods of application under average field conditions. Recent improvements in nozzles, combined with greater pressure, permitting the spray solution

to be applied as a finely divided fog or mist like spray, indicate, in our preliminary tests, a very distinct advance in effectiveness.

Of equal importance in this regard is the development of an efficient spreader which may be added to the arsenate solution. We believe that if a satisfactory spreader can be developed it will be possible to get very effective codling moth control with a dilution of 1 pound of arsenate to 100 gallons of solution. It is a matter of common experience when checking on a sprayed plot for the thoroughness of application to judge largely by the half circles and blotches of dried arsenate deposited more or less irregularly over the sprayed surface. Our conception of an efficient spreader is some material which allows the droplets to so spread out and join one another as they dry that the arsenate finally rests as an even, regular, inconspicuous covering affording a perfect and equal protection for every surface.

Suspension Tests

The surface tension and specific gravity are probably factors of importance in determining the value of a spreader, but so far the correlation of each to the other has not been determined and does not appear to be in a direct proportion. The ability of a liquid to hold arsenate in suspension does appear to be a very fair indication of its ability as a spreader, however. The materials tested, the dilutions and results are given in Table No. I.

One thousand cubic centimeters of each solution was taken, cylinders of uniform size and 1000 cc. capacity were used, and to each solution was added 5 grams of acid lead arsenate; the cylinders were thoroughly and uniformly agitated and the arsenate allowed to settle. Readings were made at the end of 5 minutes, 10 minutes, 2 hours and 6 hours.

Table I—Suspension Tests

Material	Dilution*	Readings of Settled Arsenate				
		5 Min.	10 Min.	2 Hrs.	6 Hrs.	Remarks
Sage tea	1–1000	1 cc.	1.2 cc.	3.6 cc.	6 cc.	Good
Sage tea	5–1000	.7 cc.	.9 cc.	2.8 cc.	4.8 cc.	Very good
Glue	1–1000	.8 cc.	1 cc.	3.4 cc.	6 cc.	Good
Glycerine	5–1000	.6 cc.	.9 cc.	4.2 cc.	7.1 cc.	Good
Gelatine	1–1000	.5 cc.	.6 cc.	2 cc.	3.1 cc.	Excellent
Sugar	5–1000	7.7 cc.	9 cc.	All down		More rapid than water
Honey	5–1000	3.8 cc.	4 cc.	8 cc.	All down	Poor
Gum Tragacanth	1–1000	6.8 cc.	All down			No good
Fish oil soap	1–1000	2.5 cc.	3 cc.	4.8 cc.	All down	Material flocculent
Casein-lime	1–1000	1 cc.	1.6 cc.	3.2 cc.	5.8 cc.	Good
Resin soap	5–1000	3 cc.	3.8 cc.	5 cc.	All down	Poor
Water	......	6 cc.	8 cc.	All down		

* The dilution figures refer to the number of grams or cubic centimeters of material to 1000 cc. of water; 5 grams of acid lead arsenate was added to each solution.

Some of these materials were run a second and even a third time,

but with little variation in the general results. The sugar behaved very peculiarly in actually precipitating the arsenate. The Gum Tragacanth did not go into solution and itself settled down to the lower two-thirds of the cylinder.

On Bean Foliage

A test of the solutions on bean foliage was next made, primarily for burn, but incidentally it gave an indication of great promise for two of the materials as spreaders. Twenty-five pots of a uniform size and containing similar soil were planted to an excess of common navy beans, and placed in the greenhouse to grow. When the plants had attained a fair size, 10 pots were thinned down to a single uniform bean plant and 10 were thinned to two plants and in the following experiment the single plants were used in reduced sunlight, those with two plants were used in direct sunlight. The plants were sprayed on November 14 and observations on burn were made November 19, 24, and 29. The arsenate in all cases was used at a strength of 4.8 grams to 1000 cc. of solution. The materials used and final results are contained in the following table:

Table II—Record of Burn

Materials	Dilution	November 19		November 24		November 29		Remarks
		Direct Sun	Reduced Sun	Direct Sun	Reduced Sun	Direct Sun	Reduced Sun	
Fish oil soap.	1–1000	Medium burn	Slight	No change	No change	Serious	Fair burn	Not suitable
Glycerine . . .	5–1000	Slight	General slight	General	No change	Not bad	No change	Questionable
Glycerine . . .	10–1000	Considerable	No burn	Serious	No change	Serious	Serious	Not safe
Glue.	1–1000	Medium burn	Medium burn	No change	No change	Fairly bad	Not serious	Questionable
Gelatine	1–1000	Slight	No burn	No change	No change	Slight	Trace	Good
Sage tea.	5–1000	No burn	No burn	No burn	No change	No burn	No burn	Excellent
Sage tea. . . .	10–1000	Slight	No burn	Same	No change	Trace	No burn	Excellent
Casein-lime. .	5–1000	Trace	No burn	No change	No change	Traco	No burn	Excellent
Lime-sulphur.	10–1000	No burn	No burn	Slight	No change	Fair	Slight	Questionable
Lime-sulphur.	20–1000	Scattering	Large spots scattering	Spreading bad	No change	Serious	Fairly bad	Not safe
Check		Considerable	Small, general	Spreading, general	No change	Serious	Considerable	

The two materials which gave the least burn, sage tea and the casein-lime mixture, likewise approximated the ideal sought for in a spreader. The casein-lime solution, particularly on the bean foliage, spread out evenly and uniformly, depositing the arsenate in a smooth, even, inconspicuous coating. A similar test of these two materials as spreaders on the foliage of strawberry was made and gave most satisfactory results.

Both of these materials are rather unusual and a short discussion of their preparation should prove of interest.

Sage Tea

The material referred to here as sage tea is the solution obtained by steeping one pound of cut up leaves and stems of our common prairie sage bush of Oregon (*Artemisia tridentata* Nutt.) in one gallon of water. The water is brought to a boil, removed from the fire, the sage added and the vessel covered and allowed to stand for 12 hours or more, when the liquid is drawn off. This sage tea is a brown, oily, emulsion-like solution. The oils and other ingredients present have not been determined but are probably similar to those as given by *Robak* (3) for white sage (*Artemisia frigida* Willd). The preliminary tests of the materials as a spreader so far made are not conclusive but are surely encouraging.

Casein-Lime Mixture

The suggestion of the casein-lime mixture was obtained from an abstract of an article appearing in the Agricultural Gazette of New South Wales, XXIV, pt. 10, p. 868 on spreaders for Bordeaux mixture. The material was mixed as suggested there, the procedure being as follows: To 3.5 grams of quick lime was added 1.5 grams of powdered casein. This material was ground in a mortar to a homogeneous mass. The amount to be added to the solution was then weighed out and by small additions of water and much stirring finally rendered to a thin paste and then added to the general solution. Considered chemically we may call this calcium-caseinate and as nearly as we can determine at present we probably have formed a colloidal solution. The very nature of it, its cheapness, the small amount required and apparently desirable qualities make it a material worthy of much additional study. It is suggested that from 4 to 8 ounces of the mixture to 100 gallons of solution is probably sufficient to obtain the spreading qualities desired.

Literature Cited

(1) Tartar, H. V. and Wilson, H. F. 1915. Toxic Values of the Arsenates of Lead. Jour. Econ. Ent., VIII, No. 5, p. 481.
(2) Lovett, A. L. and Robinson, R. H. 1917. Toxic Values and Killing Efficiency of the Arsenates. Jour. Agr. Research, X, No. 4, p. 199.
(3) Robak, F. 1906. U.S.D.A. Bur. Plant Ind. Bul. 235, p. 21.

If there is no discussion on this paper, I will pass to the next, "A Study of the Toxicity of Kerosene," by Mr. Moore, of Minnesota. Mr. Ruggles will read this paper.

A STUDY OF THE TOXICITY OF KEROSENE[1]

By WILLIAM MOORE, *Head, Section of Research in Economic Zoölogy,* and
S. A. GRAHAM, *Assistant, Division of Economic Entomology*

INTRODUCTION

During the summer of 1916 Marcovitch, assistant in entomology in this division, successfully sprayed a field of potatoes with pure kerosene killing the leaf hoppers, *Jassidæ,* without injuring the potato plants. Sanderson[2] states that "pure kerosene should never be used on foliage, for though occasionally someone will report using it successfully without injury, in almost all cases serious burning of the foliage results."

Kerosene and kerosene emulsions have been in general use as insecticides since the early eighties when the first papers on this subject appeared.[3] Although good results were often obtained, particularly in the use of the emulsions, it is also true that frequently either the insects were not destroyed or the foliage was severely burned.

Where burning has occurred it has been the custom of many entomologists to lay the blame to an imperfect emulsion. The result has been that within recent years the use of kerosene as an insecticide has been largely abandoned in this country. Results obtained in the study of a large series of volatile organic compounds[4] showed that the boiling point, as an index of the volatility, had considerable influence on their toxicity to insects. With these results in mind it was considered that a study of the toxicity of kerosene to both plants and insects would be of value in clearing up the irregular results frequently obtained in using this material.

KEROSENE

Kerosene is the name applied to an oil intended for burning purposes. It usually consists of those fractions of petroleum distilling over between 150° and 300° C. and is required by law to meet a certain flash test. Even from the same source such an oil may vary consid-

[1]Published with the approval of the Director, as Paper No. 93 of the Journal Series of the Minnesota Agricultural Experiment Station.

[2]Sanderson. Insect Pests of Farm Garden and Orchard, p. 49. John Wiley & Son, Pub., New York, 1912.

[3]Riley, C. V. Rpt. of Ent., Ann. Rpt. Dept. of Agr., 1884; Rpt. of Ent., Ann. Rpt. Dept. of Agr., 1886. Hubbard, H. G. Scale Insects of the Orange, Remedies and Application. Rpt. of Ent., pp. 106–126 from Rpt. of Dept. of Agr., 1882.

[4]Moore. Toxicity of Various Benzene Derivatives to Insects, Jour. of Agr. Research, vol. 9, No. 11, 1917; Volatility of Organic Compounds as an Index of their Toxicity to Insects, Jour. of Agr. Research, vol. 10, No. 7, 1917.

erably in composition due to its manner of preparation. Some are placed on the market directly as they are obtained in distillation, while others are further purified. Some consist of heavy oils which have been diluted with naphtha to give them the proper flash point, while others are heavy oils which by a special process of distillation known as cracking are broken up into oils having a lower boiling point, thus enabling them to pass the flash test. In addition to these and other types of kerosenes which may be obtained from the same source there might be mentioned an almost endless number of variations depending upon the source. The petroleum obtained from the fields of Pennsylvania, Illinois, Indiana, Texas, California, Canada, Russia, and other places, to which may be added the Scotch shale oil known as paraffin oil in England, all vary to some extent in their chemical composition. Not only do they vary in minor constiuents but even as to the series of chemicals which they contain such as the Pennsylvania oil with its paraffin base and the California oils with their asphaltic base. With these variations in mind five different oils were obtained for this study. Two of these were obtained from the same field but were decidedly different oils while the other three represented different oil fields. Only American oils were used as it is doubtful if foreign oils are usually encountered on the American market. The oils may be conveniently referred to as A, B, C, D, and E; A and B representing oils from the same field but differing in that A was more refined and a more expensive oil than B. C, D and E represented oils from other fields. These oils were all fractionally distilled into four parts with the idea of obtaining compounds of a more even chemical composition and with a smaller range of boiling points. Table I shows the different boiling points of the fractions and the per cent of each fraction to the whole.

TABLE I

Oil	First Fraction		Second Fraction		Third Fraction		Residue	
	Boiling Point	%	Boiling Point	%	Boiling Point	%	Boiling Point	%
A	140°–187°	27.2	187°–234°	42.6	234°–280°	28.2	280°+	1.9
B	160°–200°	19.5	200°–240°	57.7	240°–280°	21.0	280°+	1.7
C	135°–183°	11.1	183°–231°	66.6	231°–280°	22.2	....	...
D	150°–195°	20.0	195°–240°	60.0	240°–285°	20.0	....	...
E	150°–185°	37.4	185°–235°	46.0	235°–260°	12.2	260°+	4.4

RESULTS OF EXPERIMENTS

Toxicity to Plants

The toxicity to plants was tested by spraying tomato plants, in the

greenhouse under similar temperature and light conditions, with the unfractionated oils, the different fraction of these oils, and the oils and fractions emulsified with soap and applied at various strengths. These oils were all emulsified using the Riley-Hubbard formula with ivory soap as the emulsifier.

Results of spraying with the pure oils and emulsions of these oils are given in Table II. From these data it is evident that different

TABLE II

Name of Oil	Applied	Unfractionated	First Fraction	Second Fraction	Third Fraction
A	Pure	4(2)	5(4)	4(3)	4(1)
A	25%	1(2)	1(2)	1(3)	2(3)
A	10%				
A	5%				
A	3%				
B	Pure	4(6)	4(5)	5(4)	5(5)
B	25%	4	4	4	4
B	10%	3	3	4	4
B	5%	2	2	3	4
B	3%	3	2	3	3
C	Pure	5(5)	5(6)	6(5)	6(3)
C	25%	4(3)	3(2)	4(2)	5(3)
C	10%	3	3	4	4
C	5%	2	2	3	3
C	3%	3	2	3	3
D	Pure	5(4)	5(5)	6(4)	4(3)
D	25%	4	3	4	4
D	10%	4	3	4	4
D	5%	2	2	3	4
D	3%	2	2	2	4
E	Pure	5(2)	6	5	3
E	25%	2	2	2	3
E	10%	2	2	2	1
E	5%	2	1	2	2
E	3%	1	1	1	1
A	5% diluted with hard H_2O	2	3	3	2
D	5% diluted with hard H_2O	3	3	4	4

1—Uninjured. 2—Very slightly injured. 3—Slightly injured. 4—Injured. 5—Seriously injured. 6—Dead. Figures in parenthesis are the results of preliminary experiments carried out under varying conditions of light and temperature and illustrate how results may vary with varying conditions.

brands of kerosene differ in their toxicity to plants, and further that there is a difference in the action on plants of the various fractions of the same brand. In using the pure oil it may be noted that the lowest fraction in general injured the plants less than the second fraction, but the second fraction produced as a rule greater injury than the third fraction. In the experiments it was noted that the first fraction, containing the oils with low boiling points, penetrated the leaves very quickly and the injury was noted very much sooner than with the

higher fractions. In some brands, notably E, the injury from this fraction was greater than from any of the other fractions. In considering the emulsions it is apparent that the soap protected the plants from the most volatile portions until such time as it had evaporated, hence in emulsions the lower fractions of the oil were less injurious than the higher fractions which remained on the plants so long that they had an opportunity to penetrate after the emulsion had dried out. Some kerosenes can be used at a relatively high concentration with little or no injury to the plants, while other brands produce injury when as dilute an emulsion as 3 per cent is used. This is more interesting in that A and B, kerosenes from the same field, showed this decided difference. This is possibly due to impurities in B which are not present in the more highly refined A. The influence of using hard water in diluting the emulsion resulted in a greater injury to the plants than the spray of the same strength diluted with distilled water.

The Toxicity of Vapor of Kerosene

Inasmuch as Shafer[1] considers that it is the vapor of kerosene and similar compounds which kills insects when used as a contact spray, a study of the vapor of the different brands and their fractions was made.

In testing the vapors the house-fly, *Musca domestica* Linn., was used. The flies were placed in flasks and the amount of material required to kill them in 400 minutes was determined as described in previous papers by one of us.[2] The results are shown in Table III.

Table III—Number cc. of Oil per Liter Required to Kill in 400 Minutes

Oil	Unfractionated	First Fraction	Second Fraction	Third Fraction
A	.006237	.004158	.004752	*
B	.005454	.00297	.003267	*
C	.00594	.00297	.001782	*
D	.005346	.003584	.003584	*
E	.006534	.003861	.00297	*

* Not killed in 400 min. in saturated atmosphere.

From this table it is evident that only the lower fractions are capable of killing the insects, the higher fractions not being sufficiently volatile to produce sufficient vapor to kill at ordinary temperatures.

The amount of liquid of the second fraction which was necessary to kill the insects was far in excess of that which would volatilize and

[1] Shafer, G. D. How Contact Insecticides Kill, I and II. Tech. Bul. Mich. Agric. Exp. Sta. Bul. 11, 1911.

[2] Moore. Loc. cit.

apparently death was due to only the portions of this fraction with the lowest boiling points. From these results it would appear that only the lowest fractions of kerosene would be effective when it is used as a contact insecticide.

Toxicity of Kerosene Emulsions to Insects

To determine the accuracy of this point different kerosenes and their fractions were used in a 5 per cent emulsion as a spray for the destruction of the snowball aphis, *Aphis viburnicola* Gillette. These are sprayed with a 5 per cent emulsion of the oils and their fractions. The aphids were counted before and after spraying to determine the per cent killed. Results of these experiments are shown in Table IV.

These data show decidedly contrary results to what might be expected. *The higher fractions were in all the oils most toxic.* As a check snowball aphids were sprayed with a soap solution of the same strength as that used in the 5 per cent emulsion with the result that only 30 per cent of the aphids were killed. The effectiveness of the high boiling point fractions cannot be due to the soap in the emulsion nor can it be due to any influence on the penetration of the oils or the lower boiling points would also have shown this influence. It would appear, therefore, that the death of the insects from high boiling point compounds is not due entirely to the vapor. This matter is being investigated and will be reported later.

Table IV—Per Cent of Aphids Killed by a 5 Per cent Emulsion

Oil	Unfractionated	First Fraction	Second Fraction	Third Fraction
A	81.5	56.5	94	90
B	74	66.66	100	100
C	90	66.66	77	100
D	90	90	76	96
E	80	60	89	100

Conclusion

The results of these experiments point out conclusively the great variation in the toxicity of different types of kerosenes to both insects and plants. Although an imperfect emulsion would naturally result in injury to plants, it by no means follows that where burning does occur that it is always due to an imperfect emulsion. The cause of the burning may be entirely due to the type of kerosene used. So great is the difference between kerosenes that it is quite possible to use certain types of kerosene *pure* upon certain plants under favorable climatic conditions. Inasmuch as kerosenes even of the same brand

no doubt vary from time to time in their physical characteristics and chemical composition the use of kerosene is always uncertain. The results, however, show that kerosenes of considerable value as insecticides and of very slight toxicity to plants can be manufactured. They should, however, be manufactured for the particular purpose of insecticides to meet an insecticide test rather than a flash test.

Summary

1. Kerosene varies greatly in its physical characteristics and its chemical composition, even when coming from the same oil field.

2. Low boiling point fractions of kerosene are in general more toxic to plants than high boiling point fractions when used pure.

3. Injury by fractions with low boiling points can largely be prevented if they are applied in the form of an emulsion, since the emulsion holds the oil away from the plant until such time as it has evaporated.

4. Emulsification of high boiling point fractions does not give this protection since the oil remains on the leaf after the emulsion is destroyed.

5. Low boiling point fractions are more toxic to insects in the form of vapor than high boiling point fractions due to the slight volatility of the higher fractions.

6. High boiling point compounds are more toxic than low boiling point compounds when used as contact insecticides in the form of an emulsion.

President R. A. Cooley: I will call for the next paper, "Insecticide Tests with *Diabrotica vittata*," by Mr. Howard, of Wisconsin.

INSECTICIDE TESTS WITH DIABROTICA VITTATA

By Neale F. Howard, *Madison, Wis., Specialist, Bureau of Entomology, Truck Crop Insect Investigations.*[1]

The rôle which insects play in the transmission of certain serious plant diseases makes the control of the species involved of even greater economic importance than heretofore. During the course of investigations into the control of insects which transmit cucurbit diseases, especially the mosaic disease, the use of stomach poisons received some attention.

A trial was made on a large scale in 1916, at Madison, Wisconsin, to control the mosaic disease by controlling the striped cucumber

[1] **Published with the permission of the Chief of the Bureau of Entomology.**

beetle, which was supposed to be one of the chief factors in the dissemination of this disease. Bordeaux mixture 2–4–50, with lead arsenate paste 4–50, was applied to all cucurbits in an isolated area. Eleven acres were treated every 7 to 10 days during the first half of the season. The beetles were extremely abundant.

It soon became apparent that the control of the beetle was far from perfect, and we could notice no lessening of the destructive mosaic disease. A number of experiments were then started, with the purpose of obtaining definite data on the efficiency of the spray. Some insecticides which had been tried in a small way in the field, and which showed no injury to the plants, were also included. The results were checked during the past season.

To ascertain the percent efficiency of the Bordeaux-lead arsenate in the field, a number of beetles were collected from young squash plants immediately before spraying for the first time and twenty-four hours later. After ten days, 10 of 102 beetles collected before spraying had died, while 25 of 93 beetles collected after spraying had died. The per cent mortality of each was respectively 10.8 and 36.77, or about 26 per cent efficiency of the spray. This was surprising, for Bordeaux-lead-arsenate had been recommended for the control of the striped cucumber beetle.

A series of tests were then conducted in large cages, wooden frames and cloth top and sides, the latter with sleeves for head and arms to make handling convenient and eliminate losses. The cages were placed over single plants in the field, and a heavy muslin cloth was sewed about the stem of the plant and tacked to the sides of the cage to prevent the beetles from burrowing in the soil. A small compressed air atomizer, capacity one quart, was used in the spraying. It was aimed to cover the plants completely, a practice hardly possible under field conditions. All blossoms were plucked because of the avidity of the species for flowers, which could not be sprayed thoroughly. The beetles were left on the sprayed plants for twenty-four hours unless otherwise noted, and were then removed to Riley cages and observed daily for five days. Each cage contained 100 beetles and a check was run with each experiment. The beetles were collected from untreated fields. In most instances the living and dead beetles were counted when removed from the plants, and again at the close of the experiment. Table I gives the results of the experiments carried on in 1916.

In 1917 two experiments were performed in a similar manner but new cages of special construction were used and the losses of the active beetles in handling were greatly reduced. The cages were constructed as follows: a frame 2 feet wide, 2 feet high, and 3 feet long

TABLE I—5 EXPERIMENTS WITH 9 INSECTICIDES—11 TESTS

100 Beetles per Test. Check of 100 beetles per experiment. Beetles on plants 24 hours unless noted. Live beetles counted at beginning and end of experiment

Date 1916	Insecticide	Rate per 50 Gal.	5 Days after Put on Plants, Total		Total Killed by Insecticide (% Efficiency)
			Alive	Dead	
July 28	Lead arsenate paste	4	37	45	41
	Check		91	4	
Aug. 2	Bordeaux-lead-arsenate	{2-4, 4-}	93	1	0
	Check		91	1	
Aug. 3	Calcium arsenate powder	2	59	13	1
	Check		84	12	
Aug. 11	Check		97	0	
	Bordeaux-lead-arsenate	{2-4, 4-}	87	2	2
	Lead arsenate paste	4	90	6	6
	Sweet lead arsenate	4	85	13	13
	Paris green	1	77	20	20
Aug. 14 †	Check		*92	5	
	Cobalt arsenate paste	2	92	8	3
	Zinc arsenate powder	2	80	19	14
	Zinc arsenite powder	2	65	26	21
	Arsenic bi-sulphide	2	94	3	-0

* After four days.
† On plants 48 hours.
NOTE: Beetles killed by parasites counted as living. Beetles which escaped in handling also counted as living.

was covered on three sides and top with 20 mesh pearl wire. The fourth side was covered with heavy muslin, in which were sewed three sleeves placed in the proper positions to enable one to insert his head and arms and work with ease. The bottom was covered with heavy muslin which had been sewed about the plant.

The insecticides were used in different proportions, however, the aim being to have approximately equal amounts of arsenic pentoxide per unit of spray. Lead arsenate was used in the same proportion as in 1916, but Paris green and zinc arsenite were varied to suit, so that the former was used at the rate of 1 to 60, the latter at 1 to 40. Fish oil soap was used in each test of July 6 except in the case of the sweetened lead arsenate, at the rate of 2 pounds to 50 gallons. Chemical analyses of the insecticides showed them to be representative of the preparations on the market.

The poisoned bran mash used was made according to Farmer's Bulletin No. 747, but pulp of muskmelon was substituted for other fruit. The results of these experiments are given in Table II.

The general average of all tests gives, I believe, a very good idea of the relative value of these insecticides in the field, and what one might expect when the repellent properties of Bordeaux mixture are considered. It is true that all these insecticides are more or less repellent. This has been determined in a different series of experiments which are not recorded here. The general average may be

Table II—2 Experiments with 12 Insecticides—12 Tests

100 beetles per test. Check of 100 beetles per experiment. Beetles on sprayed plants 24 hours. Living beetles counted at beginning and end of each experiment, dead beetles counted every day. Summary given in table

Date 1917	Insecticide	Formula	5 Days after Put on Plants, Totals		Total Killed by Insecticide (% Efficiency)
			Alive	Dead	
July 6	Lead arsenate, wet	2 lbs. Pwdr. 50 Gal.	77	24	10
	Lead arsenate and molasses	50 Gal. 9 qt. Mol.	63	38	24
	Lead arsenate and Bordeaux	2–50 2–4–50	48	48	34
	Zinc arsenite, wet	1 lb. Pwdr. 40 Gal.	48	49	35
	Bran mash		24	74	60
	Paris green	1 lb. to 60 Gal.	49	43	29
	Check		87	14	
Aug. 10	Lead arsenate, wet	Same as	85	15	10
	Lead arsenate and molasses	above	81	18	13
	Lead arsenate and Bordeaux	Same as above	84	10	5
	Zinc arsenite, wet	Same as above	80	20	15
	Lead arsenate, dust	1–3 Lime	85	14	9
	Paris green, wet	1–60	87	5	0
	Check		95	5	

misleading in one respect, for sweetened lead arsenate is more effective than indicated. However, in the field, where most of the above insecticides were given a thorough trial on a good acreage in 1917, the results were not noticeably different than with any of the others, although sweets have been shown to be attractive in other experiments. The poisoned bran mash is not included in this summary, since subsequent tests showed that even sprayed plants were more attractive. The average of the two seasons' results is as follows:

Zinc arsenite, average of 3 tests	24% efficient
Lead arsenate, average of 4 tests	17% efficient
Sweetened lead arsenate, 3 tests	17% efficient
Paris green, average of 3 tests	16% efficient
Zinc arsenate, 1 test	14% efficient
Bordeaux lead arsenate, 4 tests	14% efficient
Lead arsenate dust, 1–3, 1 test	9% efficient
Cobalt arsenate, 1 test	4% efficient
Calcium arsenate, 1 test	1% efficient
Arsenic bi-sulphide (Realgar), 1 test	0% efficient

Zinc arsenate is too unstable, in its present commercial form, at least, to be of importance. Cobalt arsenate needs no further comment. Arsenic bi-sulphide is too heavy to stay in suspension and does not spread well. This fact no doubt accounts for its poor showing. Zinc arsenite is apparently more effective than arsenate of lead.

The fact that a higher per cent efficiency was indicated by collec-

tions before and after spraying in the field, than in the tests is easily explainable by the fact that the beetles had recently emerged when the collections were made, and were feeding indiscriminately. The seasonal life history of *Diabrotica vittata* must be kept in mind in interpreting all of these tests.

It is evident, as has been mentioned by others, that *Diabrotica vittata* is difficult to poison. In cases where Bordeaux mixture is of value in controlling plant diseases, it may be used to advantage with lead arsenate or preferably zinc arsenite. Under conditions which prevail in the cucumber growing sections of the North Central States, its value as a control of the striped cucumber beetle does not warrant the expense of application.

President R. A. Cooley: Do you wish to discuss this interesting and valuable paper? If not, we will pass to the next paper, "The Imported Cabbage Worm in Wisconsin," by Mr. Wilson and Mr. Gentner, of Madison, Wis.

THE IMPORTED CABBAGE WORM IN WISCONSIN

By H. F. Wilson and L. G. Gentner,
University of Wisconsin, Madison, Wis.

There is a general belief among Wisconsin canners and growers that it is dangerous to use cabbage that has been sprayed with poisons of any kind. Both canners and growers recognize the fact that the cabbage worm is a serious pest but the growers have not been free to use essential combative measures because they consisted of spraying with arsenicals.

Other investigators have already shown that cabbage sprayed with arsenicals may be eaten without danger to the consumer but in order to more thoroughly convince Wisconsin growers of these facts, the investigations from which the included data was secured were planned.

The life-history work of two seasons has shown that there are three distinct generations each year and sometimes a partial fourth. There is normally more or less overlapping of generations, especially toward the latter part of the season. The maximum emergence of adults from overwintering chrysalids occurs somewhere from the first to the middle of May, depending upon the season. The maximum emergence of adults of the first generation occurs during the first two weeks of July; and of the second generation during the first two weeks of August.

In the southern half of the state generally speaking, both early and late cabbage are grown while only late cabbage is grown in the northern sections. The early cabbage usually matures without much injury from the cabbage worm, but the late cabbage is often seriously injured and as many as 35 per cent to 40 per cent of the heads may be made unfit for market. In very severe cases entire fields are wiped out. In the northern half of the state the late cabbage sometimes matures in good condition without a single application of spray while at other times the losses are very serious.

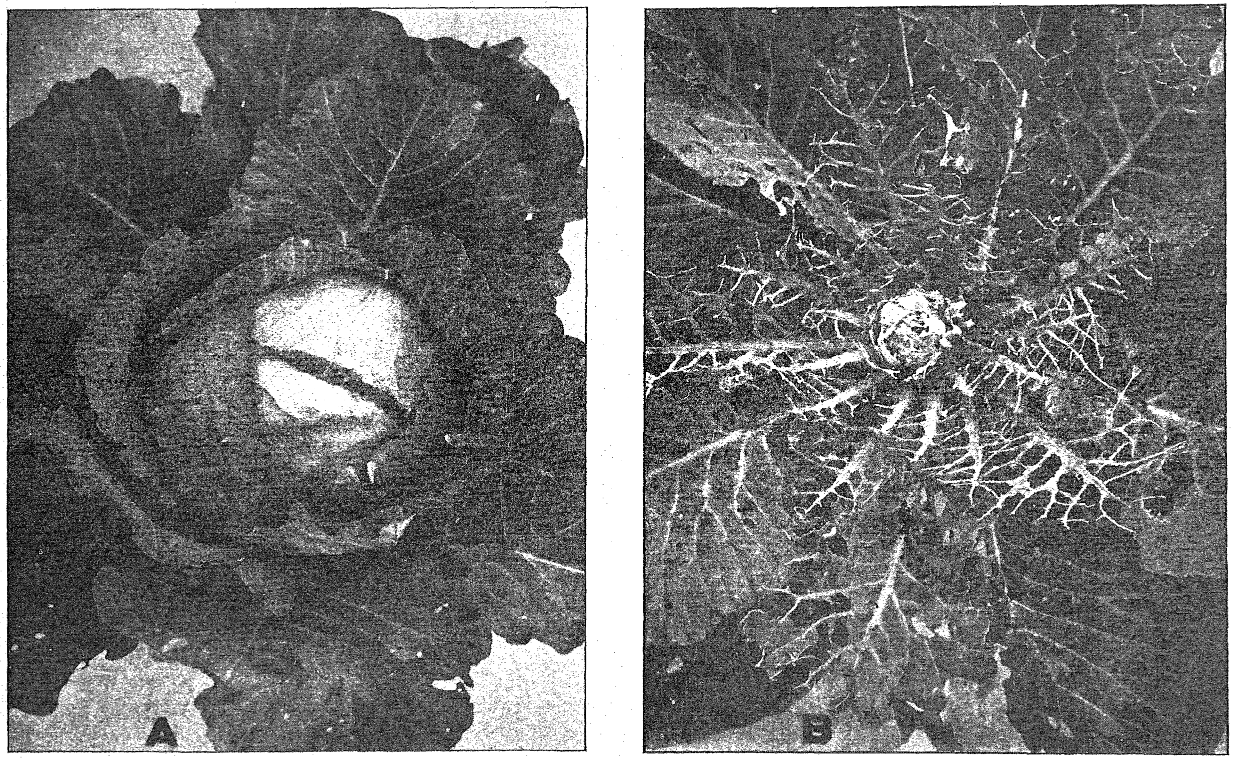
In the experiments carried on at Madison during the past year the following insecticides were used: Paris green, lead arsenate (powder and paste), zinc arsenite, calcium arsenate (powder and paste), tobacco dust and finishing lime. When applied in the liquid form the sprays were applied at the rate of one pound of the powder or two pounds of the paste to fifty gallons of water. The following materials were used as "spreaders" or "stickers": common yellow laundry soap (resin) at the rate of one or two pounds to fifty gallons of spray; molasses at the rate of one or two quarts; and molasses and lime at the rate of two quarts of molasses and three pounds of lime to each fifty gallons of spray used. When applied as a dust spray, the materials weie diluted from three to ten times by weight with lime.

The results of the experiments showed that Paris green (this was used only in liquid form), lead arsenate and calcium arsenate gave entirely satisfactory control, while, contrary to expectations, zinc arsenite failed to give control in any of the four plats to which it was applied. In fact some of the plats sprayed with zinc arsenite were practically as severely injured as the unsprayed check plat. In comparing the liquid sprays with the dust sprays, results showed that the liquid sprays gave slightly better control than the dust sprays due to the fact that the latter were more easily washed off by the heavy dews and rains. Tobacco dust and lime seemed to have practically no effect upon the cabbage worms.

Common laundry soap used with the liquid sprays at the rate of one pound or more to fifty gallons gave far better results than where either molasses alone or molasses and lime were used, due to the more even distribution of the poison in the case of the former.

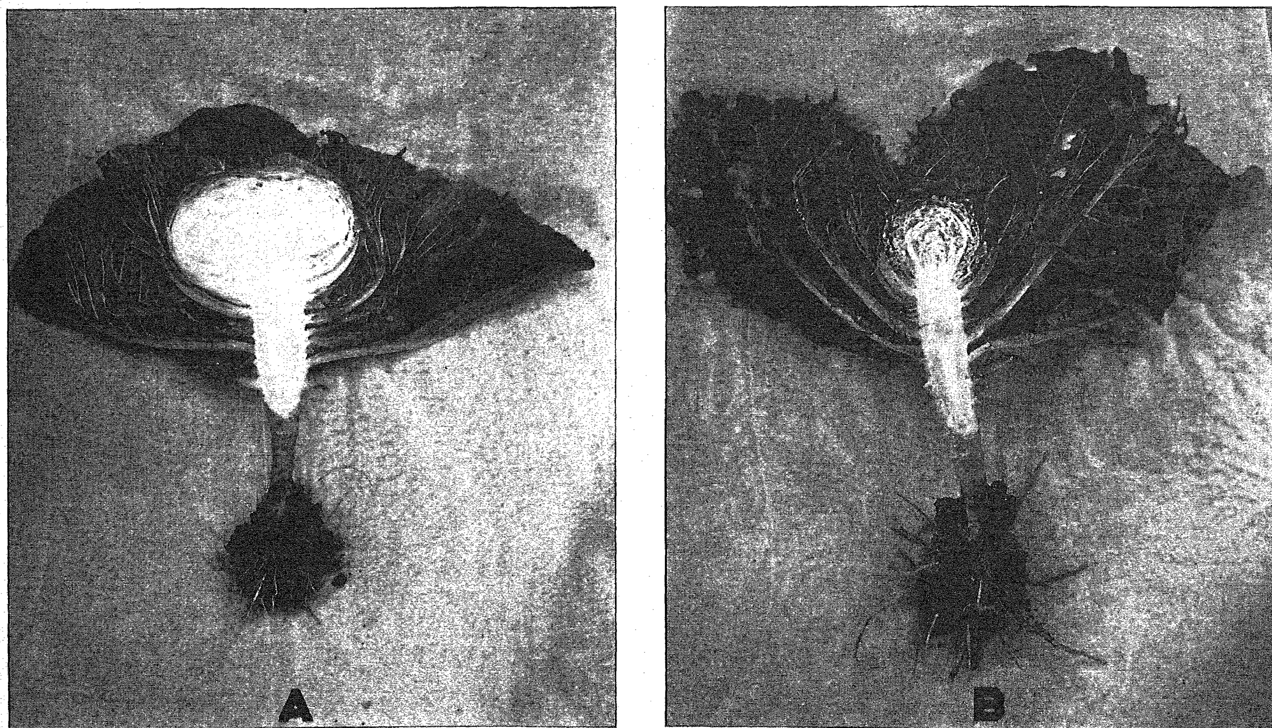
From one to two applications of spray are generally used to combat the cabbage worm. Ordinarily one application made a week or ten days after the butterflies appear in large numbers in July and another in August will give satisfactory control.

In order to determine whether or not there is any danger of poisoning to the consumer from the use of arsenicals, one head from each of six sprayed plats and one head from the check plat were analyzed by



WHY CABBAGE PLANTS SHOULD BE SPRAYED

A. Head from sprayed plat B. Average head from adjoining unsprayed plat



Why Cabbage Plants Should be Sprayed

A. Sectional view of spray protected plant

B. Sectional view of unsprayed plant showing destruction of leaves which would normally form friction cap

the Agricultural Chemistry Department of the University. The plats from which these heads were taken had received five sprayings, the last spray having been applied about a week before picking. In preparing the heads for analysis, only the outer leaves were removed as is done by the grower, then one more layer of leaves was removed to correspond to those taken off by the housewife. Not even a trace of arsenic was secured in the analyses.

Inquiries have been made with regard to feeding the outer leaves to stock, therefore an analysis was made of the outer leaves of three plants, two taken from the plats sprayed five times with lead arsenate and Paris green respectively and one sprayed twice with calcium arsenate. The results of the analysis were as follows:

Plant sprayed with lead arsenate...........	56.7	mgms.	AS_2O_3
Plant sprayed with Paris green.............	22.8	mgms.	AS_2O_3
Plant sprayed with calcium arsenate........	1.25	mgms.	AS_2O_3

These are large quantities of arsenic and would undoubtedly poison stock. The fatal dose of arsenic for mature man varies from 8 to 20 mgms.

Conclusions: While Paris green gives efficient control the cost is too high for economical use. Lead arsenate and calcium arsenate at the rate of one pound of the powder or two pounds of the paste to fifty gallons, with the addition of one pound or more of common laundry soap, give efficient control and are the most economical to use.

The failure of zinc arsenite to control the cabbage worm is not understood and further experiments will be made.

No trace of arsenic was found to be present on sprayed heads prepared for cooking even when sprayed as late as a week before picking. The outer leaves may carry enough arsenic to poison stock and are therefore dangerous to use for that purpose.

President R. A. Cooley: Do you wish to ask any questions of Mr. Gentner, or discuss his paper? If not, the next paper is, "Poisoned Bait Experiments with the Onion Maggot," by Mr. Neale F. Howard, Madison, Wis.

POISONED BAIT FOR THE ONION MAGGOT

By Neale F. Howard, *Madison, Wis.; Specialist, Truck Crop Insect Investigations, Bureau of Entomology*[1]

During the past two years many inquiries have been made concerning the poisoned bait spray as a remedy against the onion maggot, *Hylemyia antiqua* Meigen[2] (*Pegomyia* (*Phorbia*) *ceparum*, P. *cepetorum*). The writer therefore thought it advisable to give at this time a brief summary of the work performed along this line in 1915 and 1916.

The poisoned bait as a control for the onion fly was tested in an experimental way at the Wisconsin Agricultural Experiment Station in 1913, under the direction of Professor J. G. Sanders. The results obtained in this preliminary work at Racine, Wis., by Dr. H. H. P. Severin were promising.

In 1914 growers from different parts of the state reported favorable results from the use of the spray to Professor Sanders. The infestation that year was lighter than in most years, however. In 1915 the writer was stationed at Green Bay, Wis., for five months to investigate the remedy, working for the Bureau of Entomology under the direction of Professor Sanders and Dr. Chittenden. In 1916 the writer returned to Green Bay for six weeks to repeat the trial, under the direction of the Bureau of Entomology.[3]

In 1915 the poisoned bait was applied to seven acres of onions on one farm, where the writer made his headquarters, and to a slightly smaller acreage on four neighboring farms. Applications were made with a small compressed air sprayer, altered to give a coarse spray (Pl. 3, fig. 1). The operator walked up and down the fields, about every 15 or 18 feet, and released a quantity of spray every four paces. In this manner about three gallons were applied to the seven acres on the average of twice a week, weather permitting, as soon as the onions came up until the latter part of June. In the latter part of May the amount of spray applied was doubled. The bait was mixed according to the Sanders formula, as follows: 5 grams (about 1/6 ounce) of sodium arsenite, dissolved in boiling water; one-half pint of molasses; one gallon of water.

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[1] Published with the permission of the Chief of the Bureau of Entomology.

[2] Stein, in "Katalog der Palæarktischen Dipteren," Vol. 3, places *ceparum* Meigen (1830) and *cepetorum* Meade (1883) in synonymy with *Hylemyia antiqua* Meigen (1826). This fact, together with the practice of European entomologists of designating the onion fly by the latter name, makes it advisable, in the writer's opinion, to adopt it in the United States.

[3] The writer desires to acknowledge the coöperation of the Department of Economic Entomology, University of Wisconsin, and of the firm of Smith Brothers, Green Bay, Wisconsin.

By the first week in June the maggots were doing much damage to the young onions, and by the end of June the infestation was serious. Apparently no benefits whatever had accrued from the use of the poisoned bait, and the application was discontinued. One field of three acres showed a 75 per cent infestation, others 50 per cent or less.

During the next eight weeks a series of fly trap experiments were performed to ascertain the attractiveness of various baits, and to determine the killing properties of the poison. In these experiments 14 baits were used. Over 12,000 adults of the three species of root maggots prevalent in the locality were trapped, examined, and counted. The males were determined specifically, but the females were counted *in toto*. The total, 12,084, showed 59.4 per cent or 7,176 females, and 40.6 per cent or 4,908 males, of the species *Hylemyia antiqua, Phorbia brassicæ*, and *Pegomyia fusciceps*.

Of the baits used, Sanders formula, with the addition of sliced onion, proved to be 300 per cent more attractive than the unmodified bait of dilute molasses. Fresh onion ranked second, while plain dilute molasses ranked third. Of the other baits, stale beer attracted a large number of these flies as well as many others.

To determine the toxicity of the baits, check traps were included in the above experiment. Comparison of the mortality of the flies in these traps with the mortality in traps containing the same bait with sodium arsenite added, showed that from 11 to 50 per cent mortality was traceable to the poison. The general average was very low, not over 15 per cent. This would indicate that large numbers of flies are attracted to the baits but do not feed. Of course most of the flies which visited the baits entered the traps, whether they fed or not.

Collections of flies before and 2 hours after the application of the spray, on June 23, showed 20 per cent mortality due to spraying, 53 hours later.

Ten experiments were performed in the laboratory to determine if the sodium arsenite was effective at the rate used. From 12 to 56 flies were used in single experiments, and feeding was observed in almost every case. The general conclusions of all the experiments were that sodium arsenite at 5 grams to the gallon is fatal to the onion fly, the cabbage fly, and the fringed Anthomyian. The poison took visible effect in 5 to 8 hours, and was fatal in this length of time to 37 per cent (checks run in each experiment). It proved fatal in from 20 to 22 hours to 50 to 100 per cent of the flies. In several of the experiments, flies reared from onions were used. Plain molasses, which was usually fed the flies in the check, is a very suitable food. Adults have been kept living on this diet for as long as 36 days.

Reasons for Failure of Poisoned Bait in Field

Judging from the experiments mentioned above, the failure of the poisoned bait in practice may be due to one of several causes, or combinations of them. It is certain that the flies do feed on on the bait with fatal results. However, other sources of sustenance may be more attractive in nature. On the other hand, flies have been observed to feed on the bait in the field. The results of the fly trap experiments rather indicate that large numbers do not feed after visiting the bait. The most important factor has not yet been mentioned, namely, climatic conditions. In Wisconsin, the critical period in the control of the onion fly is invariably rainy. Rains not only interfered with the regular application of the spray, but in many instances washed the bait away before the flies had time to feed on it.

Investigations for Year 1916

In 1916, therefore, the bait was given a trial in the same locality, but pie tins were used to hold the liquid, and the bait was modified by the addition of a sliced onion to each pan. Eight-inch pie tins were placed at the rate of 40 or more to the acre as soon as the onion appeared through the soil (Pl. 3, fig. 2). Seven acres on one farm were thus treated, and almost as many acres on four neighboring farms. On portions of the seven acres 60 "Harper" fly traps were used, and 40 extra large fly traps constructed for the purpose (Pl. 4, fig. 1).

The pans and traps were replenished as soon after showers as possible, but the weather was extremely wet, even more so than in 1915. The experiment was started May 12 and discontinued June 25. The season was late, and when the writer was transferred to Madison on June 1, no eggs had appeared in the field or in the cages. The experiment was continued under the personal supervision of the grower, who attended to it very carefully. During June the maggots appeared in enormous numbers.

On July 3 the writer visited the fields and found that many of them had been plowed up, the devastation was so complete. The few fields which remained intact showed injury conservatively estimated, after consultation with growers, ranging from 95 to 45 per cent. Plate 4, figure 2, photographed in August, shows one of the fields injured to the extent of 75 per cent.

Conclusions

For two seasons the poisoned bait for the onion fly has given decidedly negative results.

Failure was due, to a great degree, at least, to adverse climatic conditions. These conditions are normal to this section of the country, however, and to other onion growing districts, I understand.

1

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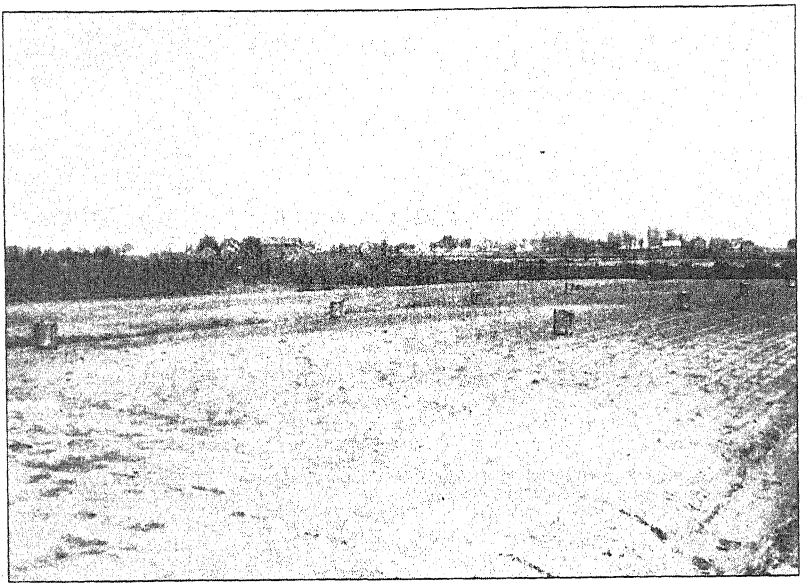
1. Method of applying poison bait for onion fly practiced in 1915. (Original)

2. Method of applying poison bait for onion fly in 1916. 100 pie tins and 53 small fly traps on three-acre field. (Original)



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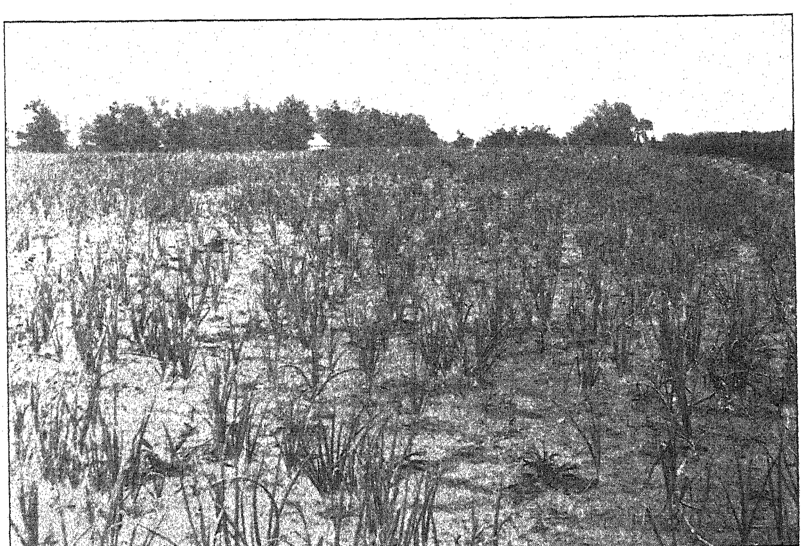

2

1. 10 large fly traps on one-quarter acre field of onions. (Original)

2. Portion of three-acre field shown in Fig. 2 (Plate 3), photographed in August. This field was injured to the extent of 75%. The area in the foreground shows a higher percentage. (Original)

In sections where the onion fly occurs and where climatic conditions are more favorable to poisoned bait applications, further trial is strongly recommended.

President R. A. Cooley: We are grateful for this contribution to a perplexing problem. Do you wish to ask questions or discuss this paper?

Mr. T. J. Headlee: I am under the impression that the investigator didn't have very good success. We have had two years' experience with it on the Sanders' plan and we have had a good deal of success. We are very enthusiastic about it.

Mr. N. F. Howard: I would like to ask Dr. Headlee if climatic conditions in New Jersey, where the experiment was tried, were similar to those in Wisconsin which I described.

Mr. T. J. Headlee: We had some rain, about fifty inches during the year; but I can't say we had continuous rain.

Mr. N. F. Howard: I should like to ask in what way the results were checked, how far from the fields were they treated, and what evidence there was that less injury on the field was not due to different conditions. In our experiments we found that we had to use great care in choosing a check. We have found the flies in the center of Green Bay, a mile and a half from onion fields, and in cruising out on Green Bay we found them on the side of the boat. Whether they were there at the time we left town or not, we don't know.

Mr. T. J. Headlee: This work was done as more of a demonstration and there were no plants immediately adjacent to the field, but there were several growing sections, and the treated areas, while pretty well removed, were perhaps within half a mile and outside of that area there were numerous fields with serious injury. There was no effort to carry on an experimental test. Where the treatments were applied, we didn't have any trouble; where the treatments were not, we did.

Mr. N. F. Howard: Several growers in the district where I worked in 1915 and 1916 recommended very strongly this method after trials in 1914; but the onion maggot infestation in Wisconsin in 1914 was very light and in 1915 it was very heavy and no benefits were gained from the application. In 1916 the infestation was still heavier and we noticed no results at all as a result of the application of this method.

Mr. J. G. Sanders: It must be remembered that our first test of this method of destroying the onion maggot was at Racine, where we had a rather dry, early growing season. Now Racine, Wis., is only a few miles above Chicago and the conditions there for testing this material were almost ideal. When I asked Mr. Howard to carry on

his tests further the next year, I purposely wished him to go into that portion of the state where we could test this material under the most adverse conditions. In Green Bay, Wis., about half-way up the western side of Lake Michigan, we usually have very wet, rainy seasons. 1915 and 1916 were unusually wet; in fact, it rained almost every day for several weeks, and I think that had a great deal to do with the failure of the application of this bait.

Dr. Headlee's report on their success under New Jersey conditions appeals to me as warranting further tests of this poisoned bait spray under reasonably satisfactory conditions.

I don't know of any other control for this terrible pest, because any of you who have been in the onion-growing districts and have seen such conditions as have been portrayed here realize what this means to an onion grower.

Mr. J. S. Houser: During the years 1915 and 1916 we attempted the use of this bait in the muck land of northern Ohio. There the weather conditions were apparently much the same as those conditions which prevailed in Green Bay, because in both seasons we had very rainy weather at the time of application and at the end of the growing season we felt that very little good had been accomplished by the application. During those two seasons the cost of the application far exceeded the value of the crops. However, we are not absolutely discouraged with the method and since it does afford some promise, we hope to repeat it in a much more thorough way and on a larger scale in the years to come.

Mr. F. Z. Hartzell: In regard to fighting of onion maggot, it is sometimes unsuccessful because of the drying of the material before the flies eat sufficient of it, and I think the plan that has just been outlined, of using pans on the onion bed, would overcome that difficulty. I think that would help at least in the dry seasons. I do not recall how Professor Headlee applied his material. I would like to ask that question.

Mr. T. J. Headlee: We applied the material by the Sanders' method, whisking it directly on the plant with a whisk-broom.

Mr. J. G. Sanders: I would suggest that any of those who are contemplating testing out this material should remember to apply this poisoned bait spray to adjacent vegetation as well as to the onion field. I think that is really more important than making the application in the fields until the onions are of fair size.

President R. A. Cooley: This investigation and discussion seems to me to be almost typical of rather a broad condition. We might be led to be discouraged and not continue these studies which now appear to be somewhat conflicting, and that in the face of the fact that this

insect is doing a great deal of damage. I believe that in many cases in the past in such investigations we have discontinued the work just at the time when we should have continued it. That is almost a typical example of what I just mentioned.

There appears next on the program, "Notes on the Biology of the Angoumois Grain Moth," by Mr. King, of Harrisburg, Pa.

NOTES ON THE BIOLOGY OF THE ANGOUMOIS GRAIN MOTH, SITOTROGA CEREALELLA OLIV.

By J. L. King,[1] *Scientific Assistant, Bureau of Economic Zoölogy, Harrisburg, Pa.*

In recent years the southeastern wheat producing counties of Pennsylvania have suffered an aggregate annual loss of over a million dollars through the yearly pillage of the wheat crop by the Angoumois grain moth (Fig. 5). Most of this loss occurs after harvest, and is due to the common practice in this region of storing unthreshed grain in the barns until some convenient time for threshing, then too, it is interesting to note that the Angoumois grain moth does *not* confine its depredations entirely to stored grain, as hitherto considered, but may begin its attack on the developing grain in the field, as is shown in the following study of the life-history.

Life-History of the Angoumois Grain Moth

On May 1, 1917, a field station was located at York in York County, Pa., for this study. Observations started immediately in a series of field investigations, and inspections of straw stacks, barns, granaries, mills and warehouses.

Hibernating Larvæ.—In the fields no evidence of hibernating larvæ could be found, nor did surrounding conditions appear favorable for them. On the other hand, mills and warehouses contained much infested wheat, but these were generally confined to the towns and cities. On the farms in the infested districts little or no wheat remained. However, in practically all the supposedly empty barns infested grain was found lodged in the cracks and crevices of the mow floor, on the beams above the mow, or under straw piles: and not infrequently hay, which had been partly covered by the sheaves of wheat, contained infested grain which had been shaken from the heads. In a number of instances large bags of mill screening were found to be literally "pure cultures" of living Angoumois larvæ.

[1] The writer takes pleasure in expressing his appreciation of the kind suggestions of Prof. J. G. Sanders, under whose direction these studies were conducted.

... larvæ pass the winter within this scattered grain in various stages of development between the half-grown and mature larval stages. In the early spring the immature larvæ again start to feed and complete their growth; the fully grown larvæ remain quiescent until shortly before the pupation period.

THE COCOON.—During the middle and latter half of May the larvæ start to spin their delicate silken cocoons within the wheat grains. The space thus occupied by the cocoon is cleared of all frass particles, this generally being packed to one side of the hollow grain, or sometimes it is cast out of the grain through a small hole which is gnawed through the side. Further preparation for final exit is made by gnawing almost through the distal end of the grain (the end opposite the plumule), leaving only a very thin circular membrane. The cocoon proper is thin and delicate, consisting of but a single layer of fine white silk which covers the walls of the cavity. After spinning the cocoon the larvæ remain quiescent for two to three days before pupation occurs.

PUPATION.—At York, Pa., pupæ were found as early as May 10, but were not abundant until after May 20.

The duration of the pupal period as observed at York during late May and early June varied from ten to seventeen days, having an average of thirteen days. When first formed the pupæ are light honey yellow, but soon turn to a golden brown as they harden. Before the final ecdysis takes place the developing moth is easily seen through the transparent pupal sheath.

EMERGENCE AND HABITS OF THE MOTHS.—The moths emerged throughout the day, but seemingly a larger per cent leave their cocoons during the morning. Escape from the cocoon is made by pushing against the thin exit membrane, which parts at the margin, and lifts as a hinged lid. The expansion of the wings is accomplished in fifteen to twenty minutes, and feeble flight is possible within an hour after emergence, but as a rule flight does not take place for several hours.

The moths are crepuscular in habit, being most active in the dusk of early evening and morning. At these times they may be observed mating and depositing their eggs.

The moths which develop from the hibernating larvæ constitute the first brood, or spring generation, which causes the initial larval damage to the season's wheat crop. This brood appears toward the end of May, and seems to reach its maximum numbers between June 5 and 15. After June 20, moths are not common.

OVIPOSITION.—As the period of oviposition is indicated by the period of the moth flight, it is worthy of note that this is also coincident with the heading of the wheat in the fields. In York, Pa., and the

surrounding country much of the wheat is in head as early as June 1, but bloom does not follow until about the 4th, continuing over varied conditions until about the 15th. However, most of the grain is well set before this latter date.

At this time a large series of experiments were conducted to determine if the adults would oviposit on green wheat, and what stages in the growth of the grain would be necessary for the sustenance and development of the newly hatched larvæ; also, to determine if oviposition naturally occurred in the field upon the green heads. Single female moths, accompanied with two or three males, were confined in small tarlatan bags, and placed over the heads of growing wheat, which was in varying stages of growth—from pre-bloom to well-set, milky grain.

In all but three cases out of forty the moths so confined deposited their eggs upon the heads of green wheat. The eggs were commonly found carefully inserted under the protecting outer and empty glumes; also, along the edge of the glumes covering the seed. However, this placement of the eggs is not unerring, as eggs are sometimes placed between the spikelets and the main stalk.

The eggs are sometimes deposited singly, but clusters of four to sixteen are not uncommon. The total number of fertile eggs per individual ranged from thirty-six to one hundred and forty-six. The average total egg production in the case of four moths under observation was ninety-two, in which case 44 per cent were deposited the first day (24 hours) after mating, and 19 per cent the second day. Later egg production decreased suddenly, falling to 3 per cent on the fourth day. Under the warm temperature of mid June, the egg stage lasts from seven to nine days. Moths in tarlatan bags in the field lived three to eight days, having an average longevity of five and two-fifths days, whereas those protected from the rigors of the weather lived an average of seven days.

Habits of the First Stage Larvæ.—Wheat in all stages of development, from the incipient seed before pollination to the green grain, in the milk is subject to the attacks of the larvæ. However, in nature few larvæ appear early enough to attack the heads before pollination.

The larvæ after leaving the eggs immediately distribute themselves over the head on which the eggs had been deposited, and almost invariably but a single larva enters each grain. The larvæ enter the grain by gnawing through the soft pericarp, either near the proximal or distal end of the grain, or through the longitudinal furrow. At first larval growth seems slow, and only slightly impedes the growth of the grain, but ultimately, as the larvæ become mature, the entire wheat grain is hollowed out.

Length of Life Cycle.—Larvæ which entered wheat while in

bloom June 13 began to emerge as adults on July 23, continuing to July 31; thus requiring from forty-one to forty-nine days from hatching of larvæ to emergence of the moths. Likewise, larvæ that entered green and milky wheat required from forty to fifty-four days to complete their development.

Inasmuch as the Angoumois grain moth has been considered an economic pest of stored grain, it seems worthy of note that the foregoing observations on oviposition and development of larvæ within unripe grain were also verified by coinciding field observations. Eggs and young larvæ were found in the growing grain during early June, and adults began to emerge in late July from the harvested grain,

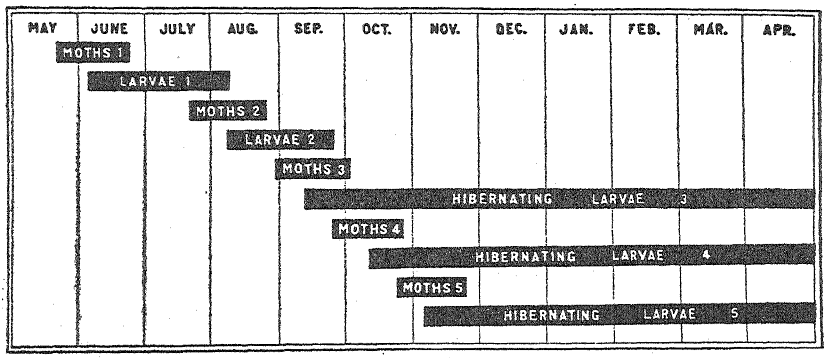

Fig. 4. Diagram of broods of Angoumois grain moth. Moths 1, first brood from overwintering larvæ in barns and granaries; Larvæ 1, larvæ in developing grain; Moths 2, second brood at harvest time; Larvæ 2, second brood larvæ occurring in field or stored grain; Moths 3, third brood in stored grain, and in part in waste grain in field; Hibernating larvæ 3, part transforms to fourth brood—remainder hibernate; Moths 4, fourth brood; Hibernating larvæ 4,—part forms fifth brood—remainder hibernate; Moths 5, fifth brood; Hibernating larvæ 5, fifth brood larvæ all hibernate.

coincident with moths reared in the experiment plots. This initial field infestation is sparse and scattered, thus accounting for the very general distribution of later broods.

Number of Generations.—The moths appearing at harvest time constitute the second generation, which occurs approximately between July 20 and August 14, with its maximum numbers during August 1 to 6. In case of late gathering-in of the harvest a small part of this brood emerge as moths in the fields, which in turn gives rise to a third brood during September 1 to September 20. This third brood is the final brood occurring in the field. On the other hand, the moths of the second generation, which emerge in the warm tight barns, carry on their depredations through as many as six, and possibly seven, genera-

tions—providing the grain remains unthreshed in the mow and severe cold weather is delayed.

Farm Practice Favorable for the Moth

A common farm practice in the region under consideration is to store the unthreshed wheat in the mow until some future time when threshing is convenient, or to thresh the grain only as there is need for the straw. This method of storing grain in the exceptionally tight and well-built barns, which are characteristic of this region inhabited by Pennsylvania Dutch, is conducive to a most rapid development of the moths. During the month of August, wheat in the mow of one of these

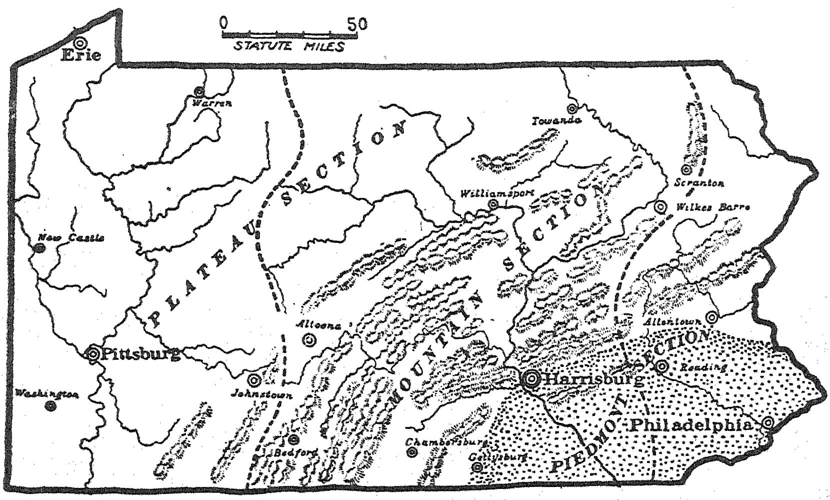

Fig. 5. Map of Pennsylvania with shaded area showing region of severe Angoumois infestation.

infested barns retained an almost constant temperature of eighty to eighty-five degrees F., and during September a temperature of seventy to seventy-five degrees F. This so stimulated growth that by the end of October as many as five generations had been reared (Fig. 4).

Control Measures

The greatest step in the control of this pest will be accomplished as soon as the Pennsylvania farmers see the fallacy of storing unthreshed grain for long periods in the mow, and will thresh as soon after harvest as possible. Grain stored in tight granaries, or in good sacks, is less liable to repeated attacks of the moth, and may be easily treated with carbon bisulphid. Further, attention to thorough barn sanitation, by the elimination or complete utilization of all scattered wheat, is of

extreme importance in checking this pest. Thorough sweeping of the mow floor and beams is necessary. Poultry enclosed in the barn will also aid in cleaning the grain from the cracks and crevices of the floor. Infested screenings if kept in the barn should be ground, or immediately used as feed, and in the future all grain should be threshed in the open to avoid reinfestation of the barn.

Finally, all sanitary work should be of a coöperative nature throughout an infested district, in order to insure against reinfestation from a negligent neighbor. Under the present conditions it is not advisable to do away with carbon bisulphid fumigation, but the writer is of the opinion, that in the future if coöperative early threshing and thorough barn sanitation are practiced, the use of carbon bisulphid will not be necessary.

President R. A. Cooley: Do you wish to discuss the paper by Mr. King on this grain pest?

Mr. J. G. Sanders: These five counties in southeastern Pennsylvania produced probably one third of the entire wheat output of the state. I think the latest figures are approximately 13,000,000 bushels. The loss in some sections last year and the year before ran as high as 75 to 90 per cent of the crop in some limited areas.

I do not think Mr. King brought out very vividly or strongly the reason why this pest seems to cause such great destruction in this area: because in this area the farmers have that unfortunate habit of storing their cut or harvested grain in the mows and then threshing it out during the winter as they need the straw, or as occasion affords. The problem of saving anywhere from one to two or three million bushels of wheat at this time is extremely important, and if we can secure the coöperation of farmers in that section of the state next spring to carry on sanitation measures in cleaning up the old hang-over wheat in every conceivable place and position, I think we would be accomplishing a very desirable result.

Ultimately, I think that the pest can be held in control by sanitation measures, without resorting to fumigation with carbon bisulfid. That is only ameliorating the condition at best; but if we can secure the coöperation of the farmers and if they will change their habits of farming, I think this pest will disappear. It is one of the most serious pests, as we now realize.

Mr. M. H. Swenk: I am interested in this because during the past summer for the first time we found this insect working in the wheat fields in Nebraska. I want to ask Mr. King definitely if he has any indications in his studies of the life-history, that it is possible for the angoumois grain moth to persist in the field throughout the year, or must it always emanate from granaries individually?

Mr. J. L. King: This study has only been conducted since the first of May. I have found larvæ hibernating in the field. I am studying them under various conditions and I have also planted infested grain, through which there seems to be some possibility that they might be carried into the soil. At first I didn't think it was at all possible, but I was greatly surprised on planting infested grain to have a few moths work their way up through the soil and they could fly away. Whether larvæ can go through the winter, I am unable to state as yet.

Mr. G. A. Dean: For at least ten years the grain moth has been one of the most serious pests we have had in Kansas in several different grains. It was first very serious in wheat, laying its eggs in the chaff and also in the stem. Now they are not causing much trouble to the wheat because the farmers thresh as soon as they can after harvesting; but it has gone into the chaff. The grain moth in Kansas is the most serious pest we have in those seeds, when stored. Our farmers must fumigate these seeds with carbon bisulfid before they are sowed. If they don't they will lose from 50 to 75 per cent of them. Our seed men had that sad experience with the angoumois moth.

President R. A. Cooley: The meeting will now stand adjourned.

Adjournment.

Morning Session, Tuesday, January 1, 1918, 10.00 a. m.

President R. A. Cooley: The first paper on the program is by E. P. Felt on "Insects and Camp Sanitation."

INSECTS AND CAMP SANITATION

By E. P. Felt, *State Entomologist of New York*

The battlefields of Europe are now the assembly grounds for the human race. Some of almost all nationalities and huge numbers of a few have met in a struggle of world-wide significance. They have brought with them their blood parasites and infections and all too frequently carriers of disease. We know that lice and typhus, flies and cholera, typhoid and dysentery, fleas and bubonic plague, mosquitoes and malaria, are to be found among the troops of the battle-scarred regions.

Here is a biological complex or association unparalleled in the history of the world and the complexity is still increasing. The dispersion at Babel is being followed by the assembly at Armageddon. Other nations are entering the conflict and at present many thousands and soon millions of American citizens may be directly involved in this gigantic struggle. We are more deeply concerned with these last, though it should not be forgotten that our future is closely linked with that of our

Allies and, moreover, that undue prevalence of disease among the enemy may, though giving us temporary advantage, ultimately react to our hurt. It should be remembered that while the problems of the war may be most urgent and vital, those that follow may be even more serious in their effects on the human race. Earlier conflicts have been followed by epidemics of disease, some extremely disastrous, and there is no reason for believing that the same will not obtain in at least some measure as an outcome of this struggle.

Susceptibility to disease is a most important factor and it is to be feared that in this respect American troops will be at a disadvantage, as compared, at least, with certain other combatants, owing to the fact that our higher standards of living have in a measure reduced resistance to disease, though this may be offset to some extent by preventive inoculations.

The importance of disease control under army conditions is not generally appreciated, though it is a well-known fact that in the Spanish War, a disturbance accompanied by very little fighting on the part of Americans, deaths from disease greatly exceeded those from wounds. The total number of deaths among the British non-commissioned officers and men in the Crimean War from April, 1854 to June, 1856 was 18,058, including all who died in the field or in the hospital from wounds and disease. Deducting 1,761 deaths from wounds, we have 16,297 deaths from disease.[1] In the South African War, 1899 to 1902, 6,965 died from wounds, as compared with at least 13,590 from disease, while 72,551 sick were invalided back to England. It is significant to note that for every man admitted to a hospital on account of wounds, 17 were admitted because of disease.[2] In 1869 there were 972 deaths from cholera among the British soldiers in India, while in 1912, with a much larger number, there were only 14.[3] The importance of affections of the digestive tract is shown by the fact that the chief epidemic diseases of the Mediterranean Expeditionary Force were enteric (typhoid) fever and dysentery. During the last six months of 1915 there were admitted in General Hospital 21 on the medical side 5,300 cases, 1,723 being classed as enteric and 1,146 as dysentery; thus more than half the medical cases came in one of these two classes.[4] Cholera was quite prevalent in Austria-Hungary, especially Galicia, from September 27, 1914 to September 18, 1915, there being 27,591 cases with 15,270 deaths.[5]

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[1] 1917. Garrison, F. H. Military Surgeon, 41: 469–470.
[2] 1917. Copeman, S. M. Journal of State Medicine, 25: 105.
[3] 1917. Goodwin, T. H. Military Surgeon, 41: 386.
[4] 1917. Bartlett, G. B. Quarterly Journal of Medicine, 10: 186.
[5] 1917. Ford, J. H. Military Surgeon, 41: 7.

The above figures give an idea of the great importance of disease from a military standpoint. It will be noted that the number of deaths in hospitals from disease exceeds and in certain cases greatly exceeds, the number of deaths from wounds. This by no means tells the whole story, since in Serbia during the winter of 1914–1915 there was a general outbreak of typhus, one in every five of the population developing the disease and 135,000 (including 30,000 Austrian prisoners) dying. The mortality ranged as high as 65 per cent though in some hospitals it was as low as 19 per cent.[1]

The results possible from the application of preventive measures is indicated by the following: During the first winter of the Crimean War the British had 2,286 deaths from fever and 129 in the second. They lost 164 men from typhus the first winter and but 16 the second. There were 3,196 deaths of British soldiers during the first winter from diarrhœal disorders and only 37 in the second winter.[2] During the first twelve months of the present war the average monthly mortality rate for disease was, in round numbers, 29 per thousand and for the succeeding eight months 14 per thousand, while for wounds the rate was 34 per thousand for the first year and 15 per thousand for the first eight months of the second year.[3]

The foregoing data has been restricted by design largely to diseases which are carried in part or entirely by the agency of insects, since this paper is primarily entomological. In not a few instances the control of disease is determined by the solution of the insect problem and this is notably true of typhus and lice, bubonic plague and fleas and mosquitoes, yellow fever and malaria. The intimate relation between insects and disease is less evident though very real in the case of flies and such affections as cholera, typhoid, dysentery and probably tuberculosis. We know that insects may be carriers of all these diseases and it has become evident within the last few months that the hardships and privations of war have been followed by numerous cases of tuberculosis and it is reasonable to expect, even if there be no epidemic, that other preventable diseases will exact a heavy toll among the unfortunate populations of the stricken areas. The situation, in our estimation, justifies the ranking of the insect menace as one of the important problems in the conduct of the war, second only to the equipment and provisioning of the army and the adequate care of the sick and wounded. In fact, insect control is intimately connected with the last. Not only is there urgent need of looking after this phase of sanitation but the probabilities are, as the war progresses, that the medical

[1] 1916. Beasley, S. O. Military Surgeon, 39: 634.
[2] 1917. Garrison, F. H. Military Surgeon, 41: 469–470.
[3] 1917. Military Surgeon, 40: 100.

and sanitary staffs will be so overwhelmed with the care and protection of the seriously stricken, that matters of apparently minor importance, such as the control of insect pests, must of necessity be neglected to some extent. As indicating probabilities along this line a note credited to Lord Northcliffe is worthy of reproduction: "It is well known now that in spite of the almost universal efficiency which characterized German preparation for the war, the German medical force dropped down entirely and was unable to meet the terrific casualties."[1] Both knowledge and reason indicate that prevention is far more effective than cure. Here is where the entomologist should step in and relieve the physician and sanitarian by discharging a duty for which he is particularly qualified. It is gratifying to note in this connection that in the "British Army every expeditionary sanitation unit of seventy men, rank and file, now includes two trained entomologists."[2] American efficiency may accomplish much, though it is hardly believable that in a few short months we can handle matters as satisfactorily in all details as a nation which has spent years in preparing for just such eventualities and for that reason, if for no other, we should take advantage of every supplemental agency.

Insect control under field and camp conditions presents many problems which cannot be foreseen. It can be handled best only by those who have had extensive experience with insects and are therefore in the position of experts so far as determining what methods should be adopted for either normal or emergency conditions. It is well known that work under the guidance of men who appreciate the possibilities is likely to be vastly more successful than that supervised by those unacquainted through experience with the problems they are expected to handle. Every economic entomologist has been the recipient of hundreds of accounts of failure to control insects, and in practically every case this has been due to not grasping the essentials though an honest endeavor may have been made to carry out directions. We submit that in cases where human life, in many instances thousands of lives are imperiled, the best is none too good and, if there be failure, the employment of experts would presuppose that every reasonable precaution had been adopted.

The work should be organized on a unit basis and a competent entomologist attached to every large military unit and accorded a ranking which will insure respect for his recommendations. There would naturally be several main lines of effort, viz.:

1. Protection against disease carriers. This would resolve itself first into the elimination, so far as practical, of opportunities for insects

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[1] 1917. Military Surgeon, 4: 31.

[2] 1917. Calvert, P. P. Old Penn, 15: 302.

to become infected, a phase which largely devolves upon the physician, though the entomologist might render conspicuous service. It would fall to the latter to see that every reasonable precaution was adopted, to reduce the breeding of insects to a minimum and to check their dissemination so far as possible. The last is of special importance with body parasites.

2. The protection of food, though vastly less important than the preceding, should receive attention, since by the adoption of comparatively simple precautions in handling and storage it would be possible to avoid waste and serious loss. Inspection by an entomologist would in most cases determine the probable source of infestation and go far toward fixing responsibility.

3. Protection of domestic animals. A general survey of camp surroundings would indicate at once the more prolific breeding places for mosquitoes, especially malarial carriers, and would incidentally disclose the localities most likely to be infested by horse flies and similar troublesome pests. The location of the camp and the disposition of camp refuse, including the manure from animals, must be determined largely by local conditions and apparently unimportant modifications may have a material effect upon the abundance of insects and the annoyance and danger resulting therefrom.

It is not expected that a flyless and insectless camp can be maintained, especially under field conditions, but it is practical, by the adoption of systematic measures, to largely reduce the insect menace, not only by the prevention of breeding but by the adoption of special means of protection wherever there is an opportunity for the dissemination of disease. The autocratic military type of organization is admirably adapted to the carrying out of such work. This latter, as has been pointed out earlier, is of particular importance in the case of American troops because they are presumably more susceptible to certain infections than men who have lived for years under less sanitary conditions.

With the above in mind, we hold that the entomologist, particularly the economic entomologist, is in a position to render invaluable service in protecting the health of our troops and that, furthermore, the efficiency of the sanitary and medical corps of the army will be greatly increased by the coöperation of such experts, since their special knowledge would permit the quick solution of many difficult problems and at the same time relieve our medical men for their very necessary and frequently more urgent duties.

There is another phase of the problem which should ever be kept in mind and that is conditions likely to obtain after the war. Almost every great war has been followed by widespread, frequently very

deadly epidemics, not only in sections directly affected but also in other parts of the world, especially those to which combatants returned. The world-wide character of this conflict makes the latter phase of great importance to all nations, since the removal of military restrictions, unless there be a rigid sanitary supervision, would give unexampled opportunities for carriers of deadly infections to make their way into other countries and spread disease. This applies to insect borne infections as well as to other maladies. Only the most thorough precautions can prevent extensive outbreaks and certain safeguards are not possible unless there is an intimate and general knowledge of the habits of insects serving as carriers.

The heavy hand of poverty is destined to rest upon extensive areas of the earth and with that may be expected a lowering of sanitary standards and a consequent increase in disease. It is most important that this latter be prevented so far as possible so that post-war conditions may not be worse than those at present obtaining. This can be accomplished by the adoption of the most effective methods for the control of disease and here the entomologist is in position to render an exceedingly valuable service not only to his country but to the entire world.

The vital importance of the effective control of disease is indicated by the following excerpts from the introduction to "Epidemics Resulting from Wars."[1]

An examination of the facts presented in the monograph "indicates that until comparatively recent times the most serious human cost of war has been not losses in the field, nor even the losses from disease in the armies, but the losses from epidemics disseminated among the civil populations. It was the war epidemics and their sequelæ, rather than direct military losses, that accounted for the deep prostration of Germany after the Thirty Years' War. Such epidemics were also the gravest consequence of the Napoleonic Wars. . . . One can point to the fact that in the present great war, the only serious epidemic that has been reported is the typhus fever epidemic in Serbia. When the medical history of the war comes to be written, however, it will be found that the aggregate losses from sporadic outbreaks of war epidemics have been very considerable. A war sufficiently protracted to lead to universal impoverishment and a breakdown of medical organization would be attended, as in earlier times, by the whole series of devastating war epidemics. And even in the case of less exhausting wars, the chances of widespread epidemics are far from negligible."

[1] Epidemics Resulting from Wars, by Dr. Friedrich Prinzing, published by the Carnegie Endowment for International Peace, Division of Economics and History, John Bates Clark, Director, p. VIII–IX, 1916.

Large portions of the world are already in the condition described in the last sentence and considerable areas have suffered so greatly that general impoverishment is almost unavoidable and as the war continues larger areas, possibly territories inhabited by several nations, will be reduced to this pitiable condition.

SUMMARY.—Diseases are responsible for more deaths in armies during war time than are caused by wounds.

Insects are known carriers of some of the most deadly infections of the soldier and the only known means of dissemination for certain of these diseases.

Available data appear to justify the opinion that over one half of all the deaths in armies due to disease are caused by infections easily and frequently carried by insects, and some only through insect agencies.

Preventive inoculation has largely eliminated the danger from typhoid fever, though it is of no value against the nearly equally deadly dysentery. The insect menace is therefore, judged from both a military and economic standpoint, most serious and its reduction to the lowest possible terms is abundantly justified. This is not only important during war time but doubly necessary at and just after the conclusion of peace.

The military history of the world abounds with appalling examples of disaster following the appearance and rapid spread of insect-borne epidemics, one such already being known in connection with the present conflict.

The experience of our adversaries in this struggle has demonstrated that there cannot be too great preparation along medical and sanitary lines, while our allies have been forced by developments to make use of available entomological talent.

It is well known that camp conditions are favorable to the development of insects and, moreover, that these pests may thrive under very diverse conditions and gain access to deadly infections in most unexpected places.

The satisfactory control of such pests requires expert knowledge based upon arduous training and extensive experience and consequently we believe that the entomologist, the man with practical experience in the control of insect outbreaks, is in position to render invaluable service in protecting the health of our troops and at the same time relieving to a certain extent members of the sanitary and medical corps for their very important and frequently most pressing duties.

PRESIDENT R. A. COOLEY: We have had presented to us a very valuable contribution on this important subject. I will now ask you to discuss this paper.

Mr. J. L. King: I think every entomologist is especially interested in the present war and is willing to give his service in any branch which will be of aid to his country. After arriving in Pennsylvania, I found that the young men in the house where I was staying had enlisted in various branches of the military service which were along the lines of their particular training, and I therefore decided to make application. I wrote to Dr. Howard in order to find out whether there was any opportunity for service in the army along entomological lines. As there did not appear to be any openings, I made application in the sanitary service, but was informed that there were no openings there. What I would like to ask is, How are the services of the entomologists to be utilized in connection with camp sanitation? It seems almost impossible to enter the service at the present time.

Mr. E. D. Ball: I would like to ask Dr. Felt whether there has been any movement made in this direction.

Mr. E. P. Felt: At the time when it began to be apparent that the United States might be involved in the war, the speaker wrote one or two editorials in favor of having an entomologist attached to every large army unit and he is still of the opinion that such is highly advisable. It may be true that our economic entomologists are largely trained in handling agricultural insects, but I think every man who has had any experience whatsoever on insect work would be willing to back such a man against one who has not had such experience. That is his life work and with his intimate knowledge of insects, he is placed in a far better position than anyone else to forecast possibilities, to see the danger points and to adapt treatment to the conditions. I am of the opinion that there must be a great amount of this kind of work done in army camps before we get the most satisfactory solution of the insect problem. Work of this kind must be taken up in advance of pressing needs or disaster may result. We must not wait, as many farmers have done, until the crop is nearly destroyed, before taking action. Life is too valuable, the stake too large to warrant this.

Mr. E. D. Ball: Dr. Felt's position is conservative. The man who has had actual field work in handling any insect pest is much better prepared to immediately take up the field end of the problem of insect control than any man approaching it from the medical, sanitation or engineering standpoint. The latter may be perfectly trained in their professions, but their knowledge of insects and their behavior is very limited. The great function of the entomologist should be to size up the situation in the field and devise suitable remedies to meet each condition that arises. The secret of the success of the American entomologist has been that he is resourceful in dealing with the problems that are placed before him.

Mr. George A. Dean: The thing that surprises me most is the fact that so few of the medical men, bacteriologists, and sanitary engineers appreciate or even recognize that the entomologists can assist in solving these health problems. As Professor Lefroy of London, who visited my department only a few weeks ago, says, it is too bad, indeed, that we have to have terrible calamities come before we wake up and take notice. He says that at the present time there is Asiatic cholera and typhus right in the localities where many of our soldiers will be sent in France, and unless we are alive to the situation and expert entomologists are in the field, we are going to have the same sad experience that the English had in the first year of their campaign. Professor Lefroy was at loss to understand why this country, so well equipped with so many capable entomologists, was not using them in all of the army camps and units.

Secretary A. F. Burgess: I think we have had a very dangerous situation pointed out to us and that we appreciate that the situation *is* dangerous. We have also had pointed out that probably very little will be done until the situation becomes very serious indeed. I believe it is time for this Association to act. If we can do no more than go on record, we should do so, and point out what the situation is and that this Association and its members stand willing to assist in this great work. The difficulty of changing a system which already exists is very great, but unless all signs fail, the time is coming when it must be changed. It seems to me that the principle of the selective draft was to place men who were selected in positions for which they were best adapted. It is a pity that men who are trained along entomological lines and are needed should not be put on that important work. The time is coming when they will be, but I think the Association ought to consider this matter very carefully and take action at this meeting, pointing out the dangers that are ahead and placing its members at the service of the government.

Mr. Herbert Osborn: I feel very deeply on this subject and hesitate to express myself fully. I feel deeply because a great many young men have come to me and asked for advice. I could not tell them what to do. I knew that they were patriotic, and it seemed to me that they should serve their country where it would produce the greatest results for the government. Under existing agencies it is practically impossible for a man to go into the service as an entomologist. It is impossible for us to reorganize the agencies to bring about an order which would provide for entomologists as entomologists. I feel very strongly indeed that entomologists are American citizens. I think every one of our members in the United States wants to render the greatest service possible in this national emergency, and I think

we may come to a point where we must do this through existing agencies. I still have hope that it may come through the selective draft,—that men who put into their questionnaires a statement of their training will finally be assigned where they are best fitted to serve. I understand that certain groups of men have not been very cordially received because of their attempt to go into the army as a class. If the entomologists can get into the service, not as a class but as American citizens ready to go where they can be of the best service, they may ultimately be placed where they are able to do effective technical work. I do not wish to make any criticism that will give the idea that entomologists are not willing to serve their country in this time of need. We are going into this matter with the utmost loyalty and we are ready to serve in any capacity that is really necessary. But I do believe our committee on resolutions could draft a carefully worded statement that there seems to be need of special service and that we have a specially trained body of men that might be of great value. It does seem a pity that the man who is thoroughly trained in entomological work and able to distinguish a fly, mosquito or other pest that is dangerous from one that is harmless—possibly save great expense or suffering and loss of life by exercising this knowledge—should not be placed where his knowledge may be of greatest value. I have two boys in the army,—one in the medical service and another, who is a trained entomologist, is in the infantry. Neither of them is able to do anything entomologically except as he may be able to offer suggestions to associates or superior officers. We ought to be very careful about making criticisms that may be misinterpreted, but we should make it plain that we are ready to do our utmost and that we wish to point out, if possible, lines along which the entomologist can assist in supporting the government agencies from a technical, scientific and entomological standpoint. Above all we want to help win this war.

Mr. E. P. Felt: I want to endorse most heartily what Professor Osborn has said. We are ready to give everything that we have and would like, if possible, to give along the most effective lines. If this Association, representing as it does the consensus of entomological opinion in the country, is willing to go on record as to the importance of this matter, I believe we will accomplish something. It isn't a question of preferment,—it is a question of rendering service. I believe that in our position as experts, we are justified in pointing out to those in charge of matters, the lines along which our men with their qualifications can work to the best advantage. That is what the government wants—to use the expert opinion of the country.

Mr. S. J. Hunter: There is another phase of this matter which has come to my attention through conferences with students who have

sought advice on this momentous subject. They will not go into this service that we all deem so important unless they can be made to feel in some official way that it is a real service that they are called upon to do for their country. I know of a number of cases of men who could have been assigned to entomological work but would not accept it as they preferred active military service, feeling that doing anything else was not fulfilling their entire patriotic duty to the country. It seems to me we ought to consider this matter.

MR. T. J. HEADLEE: The War Department has commissioned two of our mosquito men as first lieutenants in the sanitary corp. One, Mr. Russell W. Gies, is now located at Camp Pike, Little Rock, Arkansas, and the other, Mr. Jesse B. Leslie, is stationed at Camp McClellan, Anniston, Alabama. They are engaged in mosquito work. I am convinced by a personal investigation of the situation at Washington, that the condition which prevents the utilization of the economic entomologist in the preservation of army health and comfort is a notion entertained by persons in charge of such matters, that he can contribute nothing worth while to that end. It appears to be the impression that the economic entomologist is a person interested primarily in the number of spots in the mosquito's wing or the number of spines upon the flea's foot and that his information is of a type that could not be put to practical use. Until this impression is removed and the true state of the case made clear, it is not to be expected that the economic entomologist will have a chance to do his professional bit in the army of the United States. The suggestion made by our Secretary is directly to the point. This Association should go on record in the form of a resolution or a set of resolutions in which the ability of the economic entomologist to perform a real service in connection with the military establishment will be set forth. Further than this, it should provide a medium through which its action may be made clearly understood by the persons in charge of army sanitation and health.

MR. W. C. O'KANE: It seems to me that we are surely united on two or three propositions. Professor Osborn has properly said that the first of all is the matter of service. As an association and as individual members we surely propose to do that which will be of greatest value so far as we are permitted to do so, whether it be in the infantry or in entomological work. Second, I am sure that we agree with Dr. Felt that the situation in regard to camps and trenches is serious. Third, I am sure we agree that the trained entomologist can render very genuine service. I am not sure that we shall get very far by depending upon the various local boards of review. I wish I did think so, but each of these boards is, in a sense, on the defensive. There are many men coming to them who wish to do special work, and some of

these men wish to do it because they do not want to do something that might be more dangerous. That is not true of course of all men who go to them, but still it seems to me that the boards are on the defensive. Again there ought to be uniformity, so far as there is uniformity in the capabilities of entomologists. On the other hand, if we adopt resolutions here and print them in the JOURNAL, I do not know just how much weight it will have. What I am wondering is whether, if the matter were rightly presented to the War Department by two or three men representing this Association,—not as a question of exemption or of preferred classification, but as a question of maximum service—we might not get something out of it.

MR. F. C. BISHOP: I deeply appreciate the very careful analysis that Dr. Felt has given us of the situation. It certainly was a most admirable paper, and I also appreciate very heartily the comments of the various members of the Association and their effort to really put the entomologist in a position to do his greatest work in connection with the war situation. I have had a little personal experience in connection with the military camps, working largely in Texas where probably the greatest concentration of troops has been. I have come in contact more or less with the camps and regular army posts and have seen a little of the sanitary conditions. I can say that I fully agree with what Dr. Felt and others have said in regard to the need for the work of trained entomologists, and I also agree with the statements of Mr. O'Kane concerning the matter. At this time we must give very careful consideration to the interpretations that might be put upon an action of this sort, and this can best be done by a committee giving it very careful thought and then have the whole Association act following such a report.

PRESIDENT R. A. COOLEY: I have been impressed with the loyalty of the young men in the colleges who have come up for military service, many of whom, while preferring service in their own line, were willing to serve in any capacity. Some that I know have attempted to withstand public sentiment, thinking that they could perform more valuable service in their own line than to enter the army or the navy. Another point which might be mentioned in connection with army work is the need for entomologists in the service outside of medical entomology. I believe Professor Lefroy, who was recently in this country, is not a medical entomologist at all, but was here on his way to investigate the work of certain insects on stored grains. Entomologists are needed in the army for the preservation of food stores as well as in medical or preventive work.

We have in Montana a State Board of Entomology. This was created by law for the purpose of studying the control of insects that

transmit human and animal diseases. We have met with official barriers from the first in this work. I have no resentment in the matter at all and know just where the trouble is. It is merely because those high in authority do not see matters as we see them. I believe they think they are doing the very best they can, and I think it is highly desirable that there be a frank and full conference between representatives of this Association and certain men in Washington, and that very likely there will be no barrier between us at all.

MR. F. C. BISHOP: I will say for the information of those here that my understanding in the case of Dr. Jennings is that his commission in the Sanitary Corps of the army was given not because he was an entomologist, but because he was a good all around sanitarian.

MR. W. H. GOODWIN: The point made by the English entomologists concerning the preservation of food products is of vital importance. Most people have no conception of the quantity rendered unfit for food by insect infestation. Most of the material voided by insects injurious to cereals and cereal products is in the form of ureates of ammonia, and contains practically no moisture. When these are taken into the digestive system they immediately become soluble, and cause an excess of ureates which may act as toxic poisons, and in small amounts daily cause a complexity of derangements. This has been tested experimentally in a limited way by feeding cakes made from infested material to dogs, and obtaining symptoms of toxic poisoning. We can draw our own conclusions concerning insect-contaminated products used for human food and its effects.

MR. C. L. METCALF: I am a little more hopeful about the situation than some of the members who have spoken. One of my former students is in the Base Hospital at Philadelphia. He told me several weeks ago that he was pretty certain that his captain was going to utilize his services along insect lines. I am hopeful that our men going into service in the ordinary channels will be utilized by the War Department whether they are officially recognized as sanitary entomologists or not.

MR. H. A. GOSSARD: I move that a special committee of three be appointed by the chair to consider a proper course of action and draft resolutions concerning this matter.

SECRETARY A. F. BURGESS: I have a suggestion to make in this connection. At a good many of our meetings the committee on resolutions is rather an honorary job. It seems to me that if this matter were referred to them it would give them a chance to work to the limit. If the motion made has been seconded, I would like to offer an amendment that the matter be referred, in so far as resolutions are concerned, to the committee on resolutions.

MR. H. A. GOSSARD: I am just now told that already some steps have been taken by the committee on resolutions to try to meet the situation, so I will withdraw my motion.

By a vote of the Association, the matter was referred to the committee on resolutions.

MR. E. D. BALL: The committee on resolutions would request Professor Herbert Osborn and Dr. E. P. Felt to assist in the consideration of this matter and drawing of resolutions.

A motion was then made by the Secretary that a committee of three be appointed to bring any action which the Association might take through its committee on resolutions to the attention of the War Department or proper authorities in Washington. This matter was discussed freely by a number of members present, and after due consideration the Association voted that a committee of three be appointed by the President.

Adjournment.

Afternoon Session Tuesday, January 1, 1918, 1.30 p. m.

PRESIDENT R. A. COOLEY: In view of the fact that none of the past presidents have arrived, I would suggest that the discussion of the subject "How Can the Entomologist Assist in Increasing Food Production?" be thrown open for discussion by the members.

SECRETARY A. F. BURGESS: The state of Kansas has been doing a great deal of extension work, and at a good many of our meetings we have had reports from that state in connection with the successful work that has been done along that line. I don't like to embarrass any one, but I would like to ask Professor Dean if he won't open this discussion.

MR. G. A. DEAN: In view of the fact that insects cause in Kansas an annual loss of not less than $40,000,000, and that fully $25,000,000 of this amount could be eliminated if the practical methods of control that have been found effective were put into operation, your committee on insects hereby recommend to the committee on agricultural resources the following plans for doing effective work on insect control:

1. Organization of the 25 or more working entomologists of the state into a unit.

a. Office force
   - Publicity—newspaper articles and circulars
   - Correspondence
   - Planning and directing field work

b. Field force
   - Scouting work
   - Organization work
   - Demonstration work

2. Apply the methods of control that are effective and practical to the farmer. This can be done by carrying on a publicity campaign against the insects through farm papers, newspapers, farmers' institutes, granges, farmers' unions, county agents, etc.

3. Send out field men from time to time to keep in touch with any threatening outbreaks and thus be prepared to put methods of control into operation at the most important time.

4. In case of threatening outbreaks, organize the counties for concerted action. These counties can be organized by townships, as thirteen counties were in 1913 for the control of grasshoppers, or by school districts, as more than twenty counties were in 1912 and 1913 for the control of chinch bugs. The counties may be organized through the county farm agents, as several have been for the control of Hessian fly.

5. Have the entomologists in the field to actually direct the field work, because many farmers will not apply the methods which they merely read, or, if they do, will often omit some important step in the work which is vital to its success.

6. Have the county committees furnish to the Committee on Insects the names and addresses of all township superintendents in order that, in case of any insect outbreak, they can assist in the organization of the community and permit us to render help with the least possible delay.

7. Prepare short, concise articles (little more than outline) on the life-history, habits and control measures for the more important injurious insects. Copies thereof should be furnished to members of the committee and to persons employed by it or coöperating with it. The articles can be assembled in bulletin form or left separate, as seems most desirable.

8. So unify and organize all the work over the state that the greatest amount of good can be accomplished with the least expenditure of labor and money.

Mr. M. H. Swenk: The problem, as it is stated here, "How Can the Entomologist Assist in Increasing Food Production?" seems to have two parts. One is, what has the entomologist to do; the other, how can he best do it?

Our President in his address stated that for the country as a whole we have an annual loss of 10 per cent of our crops. I believe this statement was first made by Mr. Marlatt in 1904, and other entomologists have repeated it. I had some doubts about the exactness of this percentage and took pains to verify it in this way: We have one file of economic letters for the past thirty years or more, and it is safe to assume, eliminating variations which may be due to publication of bulletins, that those letters would be a fair index as to insect injury.

Especially for the past fifteen years we have analyzed these and submitted three years to very critical analysis. The three years were 1911, 1912 and 1913. The situation was analyzed carefully for each individual insect which seemed to enter into the destruction of crops that year; an average was taken and we found that for the cereal and forage crops the estimated loss ran pretty close to 10 per cent. In other words, for the state of Nebraska there was a loss of $15,000,000 annually for cereal and forage crops for the past ten years. Mr. O'Kane has further pointed out that there is a great deal of variation in the amount of control which we can bring to bear upon the situation.

Professor Bruner and myself, in going over this problem, figured that a fair average for all cereal and forage crop pests, if the information we now have could be thoroughly and consistently applied, would be about 40 per cent. We have therefore the problem in our state of saving as much as possible of about $7,000,000 worth of cereal and forage crops. That is the problem before us. As to how that can best be accomplished is the next question.

The first step it seems to me is for the entomologist to make an analysis of the situation as it occurs in his own state, to determine the pests which cause the most important losses in that state. This for the most part is a matter which would take only a short time, for the data is already at hand.

The next point is to conduct surveys and investigations and use all sources of information, to ascertain as far as possible the immediate conditions relating to those insects in the state and as far as possible to anticipate outbreaks of insect pests. This can be done in some cases; in other cases it is exceedingly difficult or impossible. As far as it can be done, however, it should be. The next point would be to employ all extension forces of all sorts, looking toward the dissemination of information in advance, or at the time of the attack, which would have a tendency to prevent or control those attacks. This may take the form of bulletins, it may take the form of personal conferences, of addresses before meetings, and perhaps other forms. It may even involve the completion of organizations destined to fight insects, the outbreaks of which can be anticipated. When the insect outbreak actually occurs, it seems to me that the placing of as large a force as possible in immediate point of infestation and the exertion of all energies possible toward the control of the outbreak is, of course, the proper thing to do.

Unsolved problems will, of course, arise. These, where they bear directly and importantly on the problem, should be given immediate and very serious attention.

The extension branch of entomology is one which in the last few

months has grown vastly in importance, with the crisis upon us, and it is now in a formative stage. This, if ever, is the most desirable time to regulate as far as possible the form of organization.

The address of our President was exceedingly illuminative on this point, showing a great diversity in the form of organization. In any event, the organization should be such that the information should come from the entomology departments and they should be responsible for it.

In connection with the growth of this special research work, we should not neglect this because it is important; there is this possible danger: that we may overdevelop, perhaps, under the immediate pressing needs the extension aspect of our problem, and while developing our trackage and rolling stock, we may neglect the power house and find that eventually a discrepancy between the fund of information at hand and the extension of it.

Mr. H. A. Gossard: Since Professor Osborn has not yet arrived, I can state what we have done in Ohio the past season and indicate briefly the conditions under which we work. At present Ohio does not have a department of extension entomology, organized as such, but an effort is being made by the State University authorities to have one in operation the coming summer.

Early the past season, Dr. Herbert Osborn, who by common consent acts as a sort of honorary dean of the entomological forces of the state, invited the heads of the state entomological departments to meet at the University. We here attempted to coördinate a sort of program for extension work.

It so happens in Ohio that economic work has been centered at the Experiment Station and I was, therefore, charged with the special responsibility of executing the general program and carrying out the details according to my judgment as to what could best be done with the limited resources at our command. I was handicapped from the start because of losing two of my experienced men to a sister state, wise enough to pay them more money than I could obtain for them. At the same time a campaign for increased food production was inaugurated by the state executive departments acting conjointly with the extension forces of the State University, and the University authorities made us a visit one day and announced they had provided twenty or more men from the University staff to give body to the organization and that to complete it fifteen or twenty additional men from the station staff must be added to the force. While I was very dubious about the wisdom of reducing my staff any more, in consideration of the seeming emergency and to please those in charge of the state's executive machinery, I consented to release for a time my associate, Mr.

Houser, who had volunteered to take up this work if it was so desired by proper authority. He therefore was a district food commissioner in charge of two counties from April to July 1. The one remaining member of my staff was appointed military instructor in Wooster University and gave four afternoons per week to military instruction. My most dependable help were graduate student assistants in the University, one hundred miles away, whose services were placed at my disposal by Dr. Osborn, they voluntarily assenting to this arrangement.

So we started on a publicity campaign and a survey of entomological conditions, so far as our funds would permit. Fortunately, the publicity campaign had been pretty well shaped up and several of the articles written during the winter while we were yet at peace with the rest of the world.

In my office, each letter is subject-indexed when it is answered. The stenographer's duty is not ended with a letter until the species that happens to be the subject of inquiry has been entered in the index-book in alphabetical order and a record made of the name of the writer, the date, and the locality from which the complaint came. We don't use the card system, it is too bulky, we use a loose-note system, each page having on it from 1 to 30 entries. We have in this way a record of every insect that has ever been a subject of complaint since the station was established. I can, therefore, tell in a few minutes if grasshoppers, Hessian flies or any other insect was present in the state in considerable numbers the preceding year or through any series of years. I can also tell at a glance from what localities they were reported. If I am not satisfied from a casual inspection of the record sheet, I can turn the record over to the clerk and ask that a map be made up from the record and in less than an hour I can have a map in hand which will show the localities from which a pest was reported the preceding year or through a series of preceding years. So I can tell about what to look for in a general way. I predicted in my early reports to Dr. Howard that we would have aphids and we did, but I was not able to specify that the potato aphid would be the conspicuous representative of this group. I was also able to indicate where the wheat-joint worm was located and to say there was little or no threat of Hessian fly or chinch bug. The Tussock caterpillar, canker-worms, curculio, potato beetle and a few others, developed exactly according to my forecast.

One of our first steps was to write to the county agents and district food commissioners, enclosing a list of manufacturers and dealers in insecticides and of makers and assemblers of spraying machinery and urge them to see that our press bulletins were given a place in their county papers; also to make sure there was a plentiful supply of insecticides and spraying materials available to their farmers. A ques-

tionnaire was also sent them regarding the injurious insects most likely to be in sight.

Just before wheat harvest I got a sufficient working staff to make a state survey. With very limited funds, I had judged it to be unwise to dissipate them in aimless wandering about the state to see what might be loose, and, therefore, timed the work to give greatest help to the crop of greatest importance during these war-times, viz., wheat. I believed the acreage could be increased if I could give the growers definite information that they were not seriously menaced by Hessian fly or other wheat insects and could safely do their seeding nearly at their own convenience. I, therefore, started four surveyors at four points on the southern border of the state and instructed them to proceed northward along four parallel lines, devoting approximately one day to each county. In laying out the routes, I paid some regard to the easiest lines of travel but aimed to make the stopping point in each county at a county seat, which was headquarters for a county agricultural agent or a county food commissioner. Then I wrote a letter to each of these county officials informing him of the purpose of the survey and requesting that he give such assistance as possible to the surveyors by way of transportation, information as to the location of the wheat districts, etc. I informed each that a day or two before my surveyor was due to arrive he would make his approach known by a long distance phone call or a night telegraph letter, and if said county officer could not be in his office the day of the surveyor's visit much assistance could be given by leaving a memorandum of the best route with the office clerk or that it might be possible to have arranged in advance a trip with some retired farmer willing and glad to loan the use of an automobile and acquainted with the wheat growers of the county. So far as I recall, every county agent visited personally responded to my request and gave most effective help to all the surveyors. One line of survey was made exclusively by automobile and this was undoubtedly the cheapest and most satisfactory means of transportation.

Each surveyor carried with him blank reports or questionnaires, one of which was filled out for each county and mailed to me or brought in by the surveyor. A hundred or more straws would be examined in each wheat field visited for Hessian fly and jointworm and the average of the day's examinations, supplemented by a general estimate, was taken as the average infestation of the county. Similar examinations were made for wheat midge and inquiries were made at every point for unusual entomological conditions. I gave a write-up of the survey in our September *Monthly Bulletin* which reaches about 50,000 Ohio farmers, published a rather full report of it in the *Ohio Farmer*, and by

means of press bulletins scattered the information through the country newspapers. I wrote a personal letter to about four to six editors in each county, enclosing a copy of the press bulletin and urging them to print it if they had not already done so.

As I remember it, our State Secretary of Agriculture estimates that the wheat acreage of Ohio has been increased from 10 to 20 per cent over last year's acreage. It is of course impossible to tell how much of this result was due to our survey, which was part of a general propaganda engaged in by several state departments to increase the acreage. I sent questionnaires to all county agents not visited, so that we had fairly accurate knowledge regarding all parts of the state. Of our 88 counties, our surveyors personally investigated 56.

We published fifteen or sixteen entomological articles, each from two to twelve or more pages in length, in our *Monthly Bulletin*, making these of a timely character. Part of these were written by the University staff. About 45 press bulletins were published. Our station editor keeps a careful record of how many papers make use of the press bulletins, and he reported to me that some of our bulletins were printed in 77 different papers and were adapted for use by two or three press bureaus. In no cases were the bulletins printed in fewer than from fifteen to twenty papers. We seemed to be getting all the publicity needful. Of course we could not determine very accurately how much of our advice was being used. In some counties, where we had the outbreak of potato aphid, the county agent would be coöperating with the horticultural department of the University, with private concerns like the Kentucky Tobacco Product Company, which had a skilled entomologist on the ground, and with us all at the same time. We only know the totals of such results. In one of our counties the saving was large as recorded in the *Bulletin* on the potato aphid recently distributed from our station.

Perhaps the methods we used are not the best that can be devised but they were the best we could think of to put into operation quickly under the circumstances previously detailed.

President R. A. Cooley: Professor Osborn has arrived and we will now be pleased to hear from him.

Mr. Herbert Osborn: I believe we may all agree that this subject can properly be widened to cover both production and preservation of food. It goes without saying that we, as good Americans, will do everything in our power to support our government in the present crisis and will respond wherever duty may call. It is also evident that a particular phase of entomological work is offered in connection with army service for the medical and sanitary phases of work and in which it may be hoped our training may be utilized. The phase of

work which is presented in this topic is perhaps of equal importance and, in this, entomological service is already recognized as of very great importance. It may be entered with hopefulness and assurance that results of value are being secured.

In this field the service of the economic entomologists may be directed along three or four distinct lines:

First, the pushing of investigations which bear most directly and urgently upon measures of protection and preservation of crops and which, it appears to me, should not be neglected during the stress of demands in fields which may for the moment seem more urgent. We may, I think, very properly, in view of the fact that many of our investigational members have been called into other lines of service, feel impelled to intensify our efforts and especially to concentrate efforts on essentials, leaving the unessential.

Second, an extensive entomological survey, or field scouting plan, for the purpose of determining as accurately as possible the conditions of insect life, the most menacing species for the immediate future and the securing of data upon which we can make recommendations to cultivators in any part of the country or for the country at large. Such data may serve the purpose of determining what crops should be omitted or given particular care or for which special preventive or control measures will be advised at critical times. A special committee with this particular duty, to work in coöperation with the executive agencies, might be of special service.

Third, a very general distribution of information through various channels, the agricultural press, experiment station bulletins, etc., and particularly through extension agencies and county agents which come most directly in contact with the class of people needing assistance in insect control. The special effort here perhaps should be to unify the recommendations made through different agencies so as to avoid the discouraging confusion to the cultivator who is dealing with problems new to his experience.

Fourth, the instruction and training of entomological workers who will be greatly needed to fill the ranks that have been thinned by the calls to the other lines of service. Every entomological teacher should feel that he has a special duty at this time to help in this direction.

There is, it appears to me, a particular opportunity to demonstrate the value of the knowledge we possess concerning the control of insects since there is so general a demand for information from cultivators, especially those who have undertaken the cultivation of small tracts or gardens as a patriotic service. The effect of this on the future demand for entomological information will, I believe, prove to be one

of the most epoch-making features of the entomological situation in connection with the present conditions.

We have, for many years, known a great number of useful control measures which it has been almost impossible to have adopted in a general way but which, once they can be shown to be profitable, will become a part of the general practice amongst fruit-growers, farmers and gardeners. The result, therefore, may be of permanent value as well as meeting a very urgent crisis at the present time.

It will be observed that these different phases of work are provided for in existing agencies, except perhaps for connected or carefully organized provision for the survey work.

President R. A. Cooley: We will be pleased to hear from Dr. Felt.

Mr. E. P. Felt: Especial stress, it seems to the speaker, should be laid upon the possibility of preventing apparently minor and comparatively insignificant losses throughout the country, since in the aggregate these count up tremendously, and in not a few instances the saving can be effected in an incidental manner and without an appreciable increase in cost for either insecticides or labor. These last will be more difficult to obtain in the future and, therefore, are important items in any plan to increase food production.

In this category we would place, possibly first of all, garden insects, especially in the case of small holdings, since here is a place where better control can be easily secured if there is only an understanding of the problems involved and the best methods of controlling the pests. It would simply be another step in making more efficient the millions of small gardeners throughout the country.

The care of stored grains and other food products is another instance along the same lines and if followed out systematically would prove an important aid in supplementing food deficiencies. This can be accomplished by well known methods, such as using up old stocks, the keeping of bins, barrels, granaries, etc., reasonably clean so there will be no centers for reinfestation and the exercise of a moderate degree of care to prevent introduction of infested material.

The adoption of every reasonable precautionary measure against insect attack is likely to be of great value and should be emphasized wherever possible; for example, in some sections of the country white grubs will be very destructive on recently turned sod land next season and the entomologist can render no better service than to make this knowledge generally available to those likely to be affected and thus save unnecessary destruction of susceptible crops, such as corn and potatoes. The efficacy of precautionary measures against such pests as the Hessian fly and the importance of promptly burning trimmings from orchards fall in the same category.

The bearing rotation of crops may have upon insect injuries should be kept in mind and improvements suggested wherever it is possible to secure greater immunity from insect damage without, at the same time, causing loss or injury in other directions. An important point in this connection is that general practice in a locality has doubtless justified itself by experience and one should consider the matter carefully before proposing innovations which in the long run may prove less successful. Preventive measures, as a rule, cost little and in these times of high prices and scarcity of help, expense and labor count for more than under normal conditions.

The value of good and clean culture cannot be too strongly emphasized, since we know that well cultivated crops will frequently outgrow insect injury that would be serious, if not fatal, to those receiving less care, and entomologists can cite numerous cases where the lack of clean culture has resulted in more or less damage, frequently serious, from insect pests. The origin of army worm outbreaks in thick weedy growths is one of the more striking instances, while the less serious damage by stalk borers and some of their allies is intimately related to an abundance of weeds.

Secondly, the entomologist should lay particular stress upon well recognized methods of controlling insects and urge activities along these lines. It is especially desirable that he should be in position, in case it is necessary, to restrict or modify spraying schedules, to indicate beyond question the applications which will give the maximum benefit at the minimum expenditure of time and money. It is particularly desirable that he limit his recommendations to methods which will surely result in benefit and preferably to those most likely to be effective in the hands of the average grower.

The present is an excellent time to question the efficacy of methods frequently recommended for the control of various insects and to ascertain whether in our enthusiasm for the theoretically perfect we may not have overstepped the line of the practical and advised treatments which in many instances would not justify themselves if a careful account was kept of profit and loss. Methods of problematical value may well be held in abeyance until further work has demonstrated their utility. There is a legitimate place for experimentation but for the present we believe, in case of large sized propositions, at least, that it is far better to advise a well-tried method, though it may be less efficient than will probably prove true of one which has not been thoroughly tested.

Now, supplementing that I would state that in New York last year we had an "Insect Pest Survey and Information Service." Through coöperation with county agents and special agents of the

State Food Supply Commission, which was organized for the special purpose of promoting production, and the other scientific agencies such as the Experiment Stations, and Cornell University, etc., we endeavored to keep in close touch with conditions throughout the state and to distribute that information promptly, preferably through county agents, so that anybody in the state would know pretty nearly what was going on, entomologically speaking. When possible we endeavored to forecast and warn as to probable developments. Of course, that is a little bit dangerous. You can't tell whether you guess right or not, but it does seem wise to put the farmers and gardeners on their guard against possible developments, with the distinct idea that they are to watch and then go ahead. Another thing I think has been brought out rather emphatically in our experience during the past year is the great value of the local agent.

We have in our state a farm bureau agent for practically every county, and last summer, under the charge of Professor Crosby, we had entomologists working in important centers.

You gentlemen appreciate as well as I, that it is surprising how many mistakes the average man can make without really trying, and we have found in hundreds of instances a man doing the wrong thing when he thought he was doing the right, and, of course, a concrete saving there means increased production. I believe, generally speaking, that we can accomplish more in conserving food supplies, etc., by emphasizing these comparatively insignificant features than we can by giving considerable attention to some larger and really more important matters. Save the small things and the larger ones will look out for themselves.

Mr. R. L. Webster: Mr. President, it seems to me that this insect survey proposition is one of the most important points that has been brought out in the whole discussion. It leads us to information that we do not get in any other way. We do not get it through our correspondence because the farmers and fruit-growers do not see these things in time, and the college people do not get it because they are not in close touch. I think this is one of the most important things in the whole situation.

Mr. F. C. Bishopp: Mr. President, I think there is one aspect of this question that has not really been touched upon and that is the relation of insects affecting live stock in the production of the meat and food supply. We have a number of instances in which insects have materially cut down the production of the meat foods and the by-products of them. This is a field which is being neglected in practice by the entomologists. It is being left a great deal to the veterinarians who unfortunately minimize the importance of these things.

I might mention a few of the insects which should receive more attention at the hand of the entomologists both at the stations and in the extension work. For instance, in the case of the development of poultry industries, which have received a tremendous stimulus on account of the war conditions—many people are starting in poultry lines for the first time. They have no conception of the various difficulties they will meet. As a result they have lost much. This has been brought about by mites and lice. The ox-warble is responsible for a tremendous loss, lice of various kinds are also responsible for the cutting of growth, and of course, the ticks of various kinds are important.

I think as I said, that we should give a little more attention to this question, especially now that the nation is so hard pressed in the production of the meat and food products derived from animals.

MR. J. J. DAVIS: We have had excellent results in our work in collaboration with the county agents. Our plan has been to carry on as much of our work as possible with the county agents. In this connection, when we first go into a county, we take up the entomological problems with the county agents; we learn from them and from personal observation what insects are important ones in that county and what insects are likely to be important ones. We then go over the whole matter with the county agent and make him thoroughly familiar with the different insects and the methods of control. We do this partly to save time for ourselves, because we cannot be in every county all the time. After we have discussed the matter in this way with the county agent so that he can handle it himself, it saves us a great deal of time.

MR. T. J. HEADLEE: In regard to the county agent problem, we find that the county agents have organized their counties into community organizations in most of the counties in the state. These community organizations are such that they cover the entire county and are sufficiently close together that when meetings are held at these places, it is only necessary to call the active farmers in the county. Through the development of the telephone service, it is now possible for a county agent to arrange a schedule within twenty-four hours if the need for it is known, and it is possible to get information promptly. The county agents with us have developed as executives—they have come to be the head of nearly all the agricultural organizations in the county. The result is that we have to appeal to the county executive to get things started.

It is perfectly practical to organize any movement necessary for the control of any insect. We know that is necessary. Our problem is one of scouting. We are scouting already for three species and we

expect to scout for at least six or eight more before the next season opens. The scouting problem is a difficult one. The most discouraging thing about the efforts of the Department of Agriculture in the way of extension work, is that it is not providing apparently for this scouting work. Some of the men are trying to handle it under the head of survey work, but I am told that no provision had been made for scouting work and that if any is done it would have to be placed under the head of surveying. That is an unfortunate thing.

President R. A. Cooley: I might mention one or two matters in my own experience. We are all familiar with the fact that many county agents have had more or less entomological training and that they have in many cases come from widely separated states. It is a case of having a little knowledge in some instances, and there is a tendency, we have noticed, for them to make recommendations which might be widely at variance with recommendations which the home institution would make. We are, therefore, undertaking to furnish all county agents with a sheet dealing with an individual pest, briefly outlining the life-history, the recommendations that the state has adopted or we believe should adopt. Another point is mentioning at the bottom of the page a few important bulletins of the home state or of another state, the purpose of this being to make the work generally more effective and specifically to bring about uniformity in the state. These sheets may be recalled from time to time and new ones substituted as additional information is available.

We are hoping to make the work somewhat more effective by this method.

We are grateful to the Horticultural Section for allowing this infringement upon their time and I will now turn the meeting over to them.

Adjournment.

The Section of Horticultural Inspection

The sixteenth annual meeting of the Section on Horticultural Inspection was held in the Carnegie Museum at Pittsburgh, Pa., January 1, 1918, at 1.30 p. m. and 8.00 p. m.

The sessions were called to order by Prof. G. M. Bentley, Knoxville, Tenn., Chairman; with Prof. J. G. Sanders, Harrisburg, Pa., Secretary. The Federal Horticultural Board and committees of the American Association of Nurserymen, and of the Society of American Florists and Ornamental Horticulturists were invited to attend the sessions to discuss and confer on the proposed bill prohibiting the importation of nursery stock from foreign countries. One member of

the Federal Board was present, but the nurserymen and florists were not represented at the sessions.

PROGRAM

January 1, 1918, 1.30 p. m., Carnegie Museum, Pittsburgh, Pa.

Address of Chairman	G. M. Bentley, Knoxville, Tenn.
Important Insect Pests Collected on Imported Nursery Stock in 1917	E. R. Sasscer, Washington, D. C.
Important Diseases Collected on Imported Nursery Stock in 1917	R. Kent Beattie, Washington, D. C.
Devastation by Imported Plant Pests Shows the Need of Quarantines against Foreign Plant Introduction (Illustrated)	J. G. Sanders, Harrisburg, Pa.
Discussion	

January 1, 1918, 8.00 p. m.

Election of officers	
The Control of Imported Pests Recently Found in New Jersey	H. B. Weiss, New Brunswick, N. J.
The European Poplar Canker in the Vicinity of Philadelphia	J. K. Primm, Philadelphia, Pa.
The Work of the Missouri Inspection Service	L. Haseman, Columbia, Mo.
Moving Pictures of Gipsy Moth Work in New England	A. F. Burgess, Melrose Highlands, Mass.

Professor Bentley spoke briefly along two distinct lines of horticultural police work, outlining first those methods successfully employed to improve nursery conditions in Tennessee, referring especially to the use of improved fumigating apparatus and chemicals. The second part of this talk referred to the extreme importance of strict quarantine on imported nursery stock.

At the close of the afternoon's program, which consisted largely of discussions of the desirability of an embargo on imported nursery stock, a special committee was appointed by the Chairman to draft resolutions pertaining to imported plants, these resolutions to be presented at the evening session.

EVENING SESSION, 8.00 P. M.

The special committee on plant importation submitted the following resolution, which was unanimously adopted:

REPORT OF SPECIAL COMMITTEE APPOINTED TO FORMULATE THE ATTITUDE OF THE SECTION ON HORTICULTURAL INSPECTION ON THE QUESTION OF PROHIBITING THE IMPORTATION OF NURSERY STOCK FROM FOREIGN COUNTRIES

WHEREAS our country is now and has for many years suffered serious financial loss from the depredations of insects and plant diseases that have come to us from abroad, —the annual damage by a single insect in some cases being greater than the total value of all nursery stock imported in the course of a year; and

WHEREAS the means of communication between the countries of the world have developed to a point that all regions are now reached through the regular channels of commerce in a portion of the time formerly required; and

WHEREAS by reason of this great improvement in transportation, species of injurious insects now confined to foreign countries, are certain soon to be introduced into our country through the importation of foreign plants; *Be it resolved:*

1. That the importation of all "nursery stock" as designated in the Federal Plant Quarantine Act of August 20, 1912, should be prohibited except as brought in under carefully guarded quarantine regulations of the U. S. Department of Agriculture.

2. That an absolute embargo against nursery stock coming in with soil about the roots should be placed at once.

3. That the prohibition against all other kinds should be placed with due regard to the time necessary to enable the businesses affected to adjust themselves to the change, after which absolute prohibition should obtain.

THOMAS J. HEADLEE,
GEO. A. DEAN,
E. D. BALL,
Special Committee.

Mr. E. C. Cotton, Chief of the Bureau of Horticulture, State House, Columbus, Ohio, was elected Chairman for 1918, and Prof. J. G. Sanders, Economic Zoölogist of Pennsylvania, Harrisburg, Pa., was re-elected Secretary.

After the reading of papers, five excellent reels of motion picture film were presented under the direction of Mr. A. F. Burgess, Melrose Highlands, Mass. These reels quickly portrayed in a short period the extension and marvelous amount of good work which has been done in moth control in New England. Few of our entomologists had any adequate conception of the delicate technique required in the promotion of parasite rearing and distribution, and the broad scope and wholesale methods employed in the field work incident to spraying, banding and other phases of control work. This exposition by the motion picture reel method conveyed to the audience more vividly and accurately a knowledge of this work, than could have been furnished in a paper requiring a half day's reading, and we trust is a forerunner of other such illustrative films in the future, and shows the desirability of a more general use of this method of instruction.

THE MISSOURI NURSERY INSPECTION SERVICE

By L. HASEMAN, *Entomologist and Chief Inspector, Columbia, Mo.*

In 1913 the Missouri legislature passed the present inspection law creating in the Agricultural Experiment Station the Nursery and Orchard Inspection Service. The law embodies the essentials of the proposed uniform inspection bill, later agreed upon by the nursery

men and horticultural inspectors and has proven to be well adapted to the needs of the state. Previous to the passage of a definite inspection law, the Agricultural Experiment Station was responsible for nursery inspection and orchard clean-up work in the state and recognizing the great educational opportunities connected with orchard and nursery inspection and clean-up work, the work of carrying out the new law was placed with the Agricultural Experiment Station. Police work of this nature accomplishes but little if not accompanied by educational work. This being true every effort has been made to accompany the police work with field teaching and demonstration work. The inspection service has not merely located San José scale in nurseries and orchards and condemned scaly stock, but it has joined hands with the entomological and horticultural forces of the Agricultural Extension Service and has gone into scale infested orchards and communities and demonstrated scale control as well as orchard pruning, general renovation of old orchards and the use of summer sprays for the control of fruit insects and diseases. Whole counties in the past three years have been redeemed for successful fruit growing, where formerly valuable orchards were being left to the mercy of San José scale, canker and other insects and diseases.

Inspection work from the point of view of police duties alone, without the follow-up work of the inspectors and the extension staff, will never redeem horticulture, where it is so widely scattered in more or less isolated communities as in this state. The duties of an inspection service are not merely to prevent further distribution of scale and other fruit tree pests, but it must help clean up trouble and encourage better horticultural methods generally, or there is little excuse for its existence. This, we believe, is the one thing which has enabled the Missouri Nursery Inspection Service to go forward with its work so successfully under most unfavorable financial conditions.

The state has never provided a cent to maintain the service, yet few states have probably made more rapid strides against nursery and orchard insect pests and diseases in the past three years. The expense of the service has been met by fees paid by our nurserymen, florists and dealers. These fees, we realize, have been inadequate, but with the hearty and enthusiastic coöperation of our nurserymen we have been able to practically eliminate San José scale and the other dangerous pests and diseases from our nurseries and to clean the communities surrounding the nurseries of similar pests, besides practically resurrecting fruit growing in a number of the best horticultural counties. We have also eliminated unscrupulous dealers and we register all agents and outside nurserymen shipping stock into the state. We are now also requiring the attachment of a Missouri tag to all incoming stock.

However, the state is still far from being safe for horticulture. There is an immense field for work still. The results which the Inspection Service has accomplished, through the coöperation of the nurserymen, fruit-growers, county agricultural agents and the other forces of the Agricultural College and Experiment Station, have won for it the confidence and good will and support of the fruit-growers and nurserymen. During the past twelve months the florists have organized the Florists' Association, the nurserymen, the Nurserymen's Association and the State Horticultural Society has taken on new life, and they are all behind the Inspection Service. This will go a long ways to insure adequate financial support from the next legislature. With the continued coöperation of the nurserymen and fruit-growers and adequate financial support, the Inspection Service will be able to carry out its full program.

THE CONTROL OF IMPORTED PESTS RECENTLY FOUND IN NEW JERSEY

By Harry B. Weiss, *New Brunswick, N. J.*

At different times during the past few years attention has been called to various foreign pests which have been found in New Jersey. At first thought, it would appear that this state has been especially favored along such lines or that the inspection service was indeed lax to allow these pests to become established. Such is not the case. During normal years nearly one-fifth of all the nursery stock imported into the United States is consigned to New Jersey. This means that we are in greater danger from an influx of foreign insects than most other states. The report of the Federal Horticultural Board for the fiscal year ending June 30, 1916, places New York first, New Jersey second and Pennsylvania third as to the amounts of stock received from abroad.

The presence of foreign pests in New Jersey is a natural result of the importation of large amounts of nursery stock. These pests have entered in spite of a well developed and well enforced system of inspection. In view of the fact that inspection will not keep everything out, the next best step is to scout continually the nurseries and places where imported stock is consigned in order to locate potential foreign pests. This has been done in New Jersey and as a result various foreign species have been found and are being controlled. This inspection or scouting must be done by trained men, men who are familiar with the native fauna and can recognize new things, men who are interested in entomology or plant pathology for its own sake and who can be trusted to cover the ground faithfully. It is a regrettable fact

that in many cases, inspection work is entrusted to students and to inspectors whose usefulness does not extend further than an ability to recognize San José scale, crown gall, gipsy moth egg masses and brown tail nests. We have tried all kinds of inspectors and have come to the conclusion that considering the importance of inspection it pays to employ competent men. It is true that during the rush seasons we are forced to employ men whose training leaves much to be desired but these men are certainly not placed at danger points.

The finding of various foreign insects in New Jersey during recent years has been due entirely to the activities of competent inspectors. In order to prevent these pests from spreading within the state and to prevent them from being carried outside of the state, various methods of control have been pursued. The following is a list of the more important insects together with the treatment which has been followed in New Jersey.

Gryllotalpa gryllotalpa L. (Orthop.). The European mole cricket has been present for several years in a small nursery area planted to a rose garden and exhibition stock. There is very little danger of this insect being carried out of the nursery in soil around the roots of plants as long as it is not allowed to spread. For the past two years, the entire infested area has been gone over and the egg nests destroyed during June and July. Special men, expert in detecting the nests, do this work and up to the present they have been successful in keeping this European pest down to comparatively harmless numbers.

Monarthropalpus buxi Lab. (Dip.). The boxwood leaf miner has been found in several nurseries and on one estate in New Jersey. On account of unsatisfactory methods of control for this species, infested plants in nurseries are ordered destroyed and certificates are withheld until this has been accomplished.

Evetria buoliana Schiff. (Lep.). This species, known as the European Pine-Shoot Moth, was found several years ago in two nurseries. Certificates were withheld at that time until every infested shoot had been cut off and destroyed. At the present time no infestations are known to exist in nurseries.

Gracilaria zachrysa Mey. (Lep.). This moth, known as the azalea leaf miner, has for the most part confined its attention to azaleas in greenhouses and is not likely to be shipped outside of the state. Spraying with arsenate of lead and fumigation with tobacco extracts have been fairly successful in controlling it.

Plagiodera versicolor Laich (Col.). This Chrysomelid exists in several nurseries and other localities, but feeding as it does in both larval and adult stages on the foliage of poplar and willow, it is readily controlled by arsenicals and is in no danger of being transported on nursery trees.

Popilia japonica Newm. (Col.). Recognized as a pest of grape, beans, peas and peanuts in Japan, this scarabaeid was recently found feeding on roses, ampelopsis, grape, elder, crataegus and button bush in a nursery and on various weeds adjoining the nursery. It was probably introduced into the state in the larval stage in the soil around iris roots imported from Japan. It is regarded as a pest in that country and at present plans are being made in coöperation with the Federal Bureau of Entomology in an effort to exterminate it. In the meantime, precautions have been taken to prevent its distribution in soil around nursery stock.

Diprion simile Hart. (Hymen.). This saw-fly, which was first noted in this country by Dr. Britton, was found in several New Jersey nurseries during the past year or so. In all cases good results were obtained by spraying infested pines with arsenate of lead. Moreover this saw-fly appears to have an effective parasite in the shape of *Monodontomerus dentipes* Boh.

Trioza alacris Flor. (Hem.). This species was introduced from Belgium where it is known as the bay flea louse and where it does considerable damage to the foliage of bay trees. The nymphs curl the leaves and in severe infestations the trees are rendered valueless as ornamentals. At the present writing it occurs only in one nursery in New Jersey and is being brought under control by fumigation with tobacco smoke during the winter. At this time the trees are in storage sheds and hibernating adults are readily killed if the fumigation takes place on warm days when the adults are not completely dormant.

Stephanitis pyrioides Scott. (Hem.). This lace-bug, which is injurious to evergreen azaleas, unfortunately became widely distributed in New Jersey before it was noted. As a result its control outside of nurseries is a difficult problem. It was introduced in the egg stage in azaleas from Japan and is known to occur in Pennsylvania and in the District of Columbia. In New Jersey nurseries it is being controlled by sprayings with whale oil soap in late May or early June after the eggs have hatched.

Peridermium strobi. During 1916 the white pine blister rust was discovered by federal scouts in four nurseries and one estate. At this time a total of 67 pines were found infested. All were destroyed and the blocks in which they were found were placed under quarantine for an indefinite period.

During 1917, our inspectors together with federal scouts found only a total of 15 diseased pines in two of the nurseries where the disease appeared in 1916. No new places were found to be infected. The state has been fairly well scouted over, due to the help which we re-

ceived from the federal Bureau of Plant Industry and it is felt that the outlook for control is fairly hopeful in New Jersey.

Other Imported Pests. At various times during the past few years weevils such as *Acythopeus orchivora* Blackb., *Cholus cattleyæ* Champ., *Cholus forbesii* Pasc., *Diorymellus lævimargo* Champ., and two species as yet undescribed have become established in New Jersey orchid houses where some of them have done considerable damage. Most of them are natives of tropical America and very little is known of their life-histories. As a result hand picking of the beetles or destruction of badly infested parts is practiced.

Another weevil, of European origin, however, which has been taken in New Jersey is *Magdalis barbicornis* Latr. According to Blatchley & Leng (Rhync, or Weevils of N. E. Amer.), this species has been taken also in New York and Massachusetts. In the recently issued government publication, "A Manual of Dangerous Insects Likely to be Introduced in the United States through Importation," it is listed as a pest likely to be introduced in apple, quince and medlar trees and known as the apple-stem piercer. In the above publication which supplies a long felt need, hundreds of foreign insects are listed as likely to be introduced, principally on nursery stock.

Inasmuch as practically all of the nursery stock imported into New Jersey consists of ornamentals, it is interesting to note that 42 species are likely to be imported on alder, that 22 might come in on ash, 60 on beech, 44 on birch, 19 on cedar, 28 on elm, 83 on oak, 16 on linden, 14 on hawthorne, and 227 on various conifers, most of them belonging to the Coleoptera, Lepidoptera and Hemiptera. If importations continue as time goes on, it is not unlikely that we will eventually have all of them in New Jersey.

IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IMPORTED NURSERY STOCK IN 1917

By E. R. Sasscer, *Washington, D. C.*

In spite of the disturbed conditions in Europe during the fiscal year 1917, the five principal European countries exporting nursery stock to the United States offered for entry some three million more plants than was the case in the fiscal year 1913, one year before the war. The following table indicates the amount of nursery stock received from these countries for the past five years.

As the result of state and federal inspection, the following important insects have been intercepted on nursery stock during the calendar year: Egg masses of the gipsy moth (*Porthetria dispar* Linn.) were

TABLE SHOWING THE AMOUNT OF NURSERY STOCK OFFERED FOR ENTRY THE PAST FIVE FISCAL YEARS

	1913		1914	
	Nursery Stock	Seed Pounds	Nursery Stock	Seed Pounds
Belgium	704,927	....	720,891	165,000
England	2,578,174	....	2,267,285	....
France	30,812,059	....	29,024,187	2,073
Germany	1,360,398	7,020	194,186	1,049
Holland	5,274,944	....	4,602,954	....

collected on three occasions, once from Belgium and twice from France, hosts not given, and one nest of the brown-tail moth (*Euproctis chrysorrhœa* Linn.) was taken on apple from France. Larvæ of the swan or gold-tail moth (*Porthesia similis* Fuessl) have been found on rhododendron, laburnum, and roses from Holland. According to European writers, this insect is a general defoliator of forest trees, and, such being the case, every effort should be made to prevent its establishment in the States.

Nests of the fruit tree pierid (*Aporia cratægi* L.) have been located in six shipments of deciduous fruit tree seedlings from France. The larva of this insect is a general feeder and is recorded as injuring the foliage of fruit trees, wild rosaceous plants, and oak trees.

Larvæ of the sorrel cutworm (*Acronycta rumicis* L.) have been collected on four occasions, twice on rose stock and once on Cornus from France, and once on azalea from Belgium. It is difficult to predict how serious a pest this would develop into if established in this country. In Europe it feeds on the foliage of strawberries, hops, and various shrubs and trees. The bay psyllid (*Trioza alacris* Flor.) was reported on a shipment of Belgian bays, and the box psyllid (*Psylla buxi* Linn.) and the box leaf miner (*Monarthropalpus buxi* Lab.) have been collected on boxwood from Holland. As in previous years, egg masses of the European tussock moth (*Notolophus antiqua* Linn.) and pupæ of the dagger moth (*Apatela auricoma* Fab.) have been repeatedly taken on miscellaneous French and Holland stock. What appears to be the cocoons of a sawfly (*Emphytus cinctus* Linn.) have been collected on four shipments of roses from England.

Ninety pounds of seed of *Prunus sargentii* from Japan, received in Washington, were found to be slightly infested with *Anthonomus bisignatus* Roel., which, judging from the condition of infested seed, is a very unwelcome guest. This shipment was fumigated in vacuum with carbon bisulphid at the rate of 3 lbs. per 1000 cu. ft. with an exposure of 24 hours. As an additional safeguard, the entire shipment was stratified in boxes covered top and bottom with a 24 mesh per inch wire screen. One of the chaff scales (*Parlatoria chinensis* Marlatt) was taken on *Pyrus sinensis* and *P. ussuriensis* from China. The

BY THE FIVE PRINCIPAL EUROPEAN COUNTRIES EXPORTING PLANTS TO THE UNITED STATES

1915		1916		1917	
Nursery Stock	Seed Pounds	Nursery Stock	Seed Pounds	Nursery Stock	Seed Pound
1,114,089	......	1,065,864	20	812,101	.....
3,914,901	......	2,872,745	5,625	3,108,143	5
41,604,161	40,053½	38,202,978	30,210	25,757,912	54,820
177,994	821¾	....	82	....	......
6,539,416	6	9,562,421	......	13,915,087	......

introduction and establishment of this coccid into the States would be a misfortune, since in China it is apparently a serious pest, having been collected in large numbers on crab-apple, Hibiscus, Zizyphus, and *Thuja orientalis*. Chestnut trees from Japan exhibited galls made by and containing living larvæ of a species of *Agrilus*, and azaleas from Belgium and Holland were infested with the azalea leaf miner (*Gracilaria zachrysa* Meyrick).

Plants of tropical or subtropical origin have also brought in a number of insects, which, if allowed to become established, would seriously handicap some of the new industries, which in recent years have given so much promise. The mango weevil (*Sternochetus mangiferæ* Fab.), one of the most injurious mango insects in tropical countries, was collected in seed from India, and *Coccus mangiferæ* (Green) arrived on the same host from Cuba. Several shipments of Guatemalan avocado seed have shown infestation with a species of *Stenoma* and also what appears to be an undescribed species of *Conotrachelus*. Both of these insects make deep ramifying tunnels in the seed and are no doubt fully as destructive as the avocado weevil. Avocado cuttings from the same country were infested with the following coccids: *Aspidiotus subsimilis* Ckll., *Aspidiotus* sp. (near *cocotiphagus*), *Chrysomphalus scutiformis* (Ckll.), *C. personatus* (Comst.), *Pseudoparlatoria ostreata* Ckll., *Lepidosaphes mimosarum* (Ckll.), *Diaspis* sp., *Ceroplastes* sp., *Solenococcus* sp., *Lecanium* sp., and *Coccus* sp. Judging from the amount of sooty mould on the cuttings at the time of arrival, it is evident that the *Coccus* secretes honeydew copiously and doubtless represents a very undesirable introduction.

The fig scale, *Lepidosaphes ficus* (Sign.), was intercepted on fig trees from Spain. This fig pest of Europe was introduced into California about seven years ago and is now thoroughly established, being distributed over a tract of some one hundred acres. The papaya fruit-fly (*Toxotrypana curvicauda* Gerst.) was taken in fruit of the papaya from Cuba; cocoanuts from Ceylon were infested with *Phenacaspis eugeniæ* (Mask.); bamboo from Japan was infested with *Antonina crawii* Ckll., and the sugar-cane mealybug (*Pseudococcus sacchari* Ckll.) was received on sugar-cane from Jamaica, Trinidad, and Hawaii.

No less than 73 distinct species of insects have been collected on orchids during the past calendar year, 64 of which were of South American origin. Of this number, there were 20 species of ants, the majority of which are now established in this country. However, there are certain forms which have not gained a wide distribution, and every effort should be made to prevent their further introduction and spread. For example, *Pheidole anastasii* Emery, which was in *Phormium tenax* from the Azores, has in recent years become a very troublesome pest in the greenhouses of the Department of Agriculture, harboring and transferring mealy-bugs and aphids from plant to plant. The so-called "crazy ant" (*Prenolepis longicornis* Latr.), an introduced species, has also been intercepted on incoming nursery stock. This ant has acquired a foothold in the Gulf States and is a household pest as far north as Boston. A species of *Iridomyrmex* was found in a shipment of *Theobroma cacao* from Java and, if allowed to become established in the United States, would eventually be a very troublesome pest, if one is to judge from the activities of the Argentine ant.

In addition to the ants, what appears to be an injurious Pyralid larva was collected in four shipments of Colombian orchids. The Cattleya midge (*Parallelodiplosis cattleyæ* Felt) was collected in orchids from Brazil, Colombia, Guatemala, and Mexico, and 15 species of scale insects were taken on shipments from Panama, Guatemala, New Zealand, Colombia, Philippine Islands, Costa Rica, England, Jamaica, Venezuela, and Brazil. Since 1912 137 species of insects have been collected entering on these plants, including 41 scale insects, only 13 of which are now established in this country. In an effort to prevent the further introduction of these pests, all orchids arriving from countries without a recognized inspection service are being fumigated at the port of entry.

The following list indicates, by countries, the number of species of insects reported by state and federal inspectors from December 16, 1916, to December 16, 1917:

NUMBER OF SPECIES OF INSECTS COLLECTED BY STATE AND FEDERAL INSPECTORS, AND REPORTED FROM DECEMBER 16, 1916, TO DATE

(Prepared from reports received to December 16, 1917)

Guatemala	48	England	21
Colombia	47	India	14
Holland	40	Venezuela	14
Cuba	36	Argentina	11
China	33	Philippine Islands	11
Japan	29	Hawaii	10
France	28	Australia	9
Brazil	27	Curacao, D. W. I.	9
Belgium	24	Trinidad	9

Java	8	British Guiana	2
Jamaica	7	Canada	2
Mexico	7	Denmark	2
Antigua, B. W. I.	6	Palestine	2
Italy	6	Porto Rico	2
New Zealand	6	South Africa	2
Bermuda	5	Virgin Islands	2
Costa Rica	5	Angola, Africa	1
Egypt	5	Canary Islands	1
Straits Settlements	5	Ceylon	1
Algeria	4	Dominica, B. W. I.	1
Canal Zone	4	Dominican Republic	1
Eucador	4	Madeira	1
Haiti	4	Mauritius	1
Panama	4	Natal	1
Paraguay	4	Newfoundland	1
Spain	4	Nicaragua	1
Azores	3	Northern Nigeria	1
Bahama Islands	3	Portugal	1
Honduras	3	Reunion	1
Peru	3	Russia	1
Saint Lucia, West Indies	3	Turk's Islands	1
Scotland	3		

THE EUROPEAN POPLAR CANKER IN THE VICINITY OF PHILADELPHIA, PENNSYLVANIA

By James K. Primm,
Bureau of Zoölogy, Harrisburg, Pa.

While inspecting the nurseries of Pennsylvania in the summer of 1917 a good opportunity was afforded to become acquainted with the disease known as European poplar canker (*Dothichiza populea*). In only one of the numerous nurseries growing poplar trees within a radius of thirty-five miles of Philadelphia this fungous had not become well established. Trees of all ages were attacked, one- and two-year-old stock much less seriously, however, than trees three or four years of age. This apparently higher resistance in young trees, noted especially in Carolina poplars, is modified by the fact that younger trees are damaged less by storms and have not been topped or pruned to any extent. The degree of infection varied from single isolated twig cankers to numerous and confluent trunk cankers. The most virulent attacks were on trees that had been pruned close to the trunk to a height of three to five feet.

The resistance of young trees is even more marked by the slight percentage found to be affected when comparison is made with older stock. In one-year stock only 2 or 3 per cent were found to be infected.

Considerable increase was noted on two-year trees, and while variable, about 18 per cent of the two-year stock was usually affected with isolated cankers on the trunk or limbs. In three-year stock and older, over 50 per cent was found to be cankered while in some blocks of two or three hundred trees, none were found free from the disease, and the greater part were wholly or partially dead from the severe attacks of numerous trunk cankers.

The species of Populus found to be attacked by Dothichiza are the following: *P. nigra* var. *italica*, Lombardy poplar; *P. alba* var. *pyramidalis*, Bolle's poplar; *P. balsamifera*, balsam poplar; *P. trichocarpa*, black cottonwood; *P. deltoides*, cottonwood; *P. eugenei*, Carolina poplar; *P. angulata*, hybrid Carolina poplar. Of these all but the first two mentioned are meeting with less favor as shade or ornamental trees and are being gradually discarded by nursery men. Another species not mentioned in the list, like Japan poplar (*P. maximowiczii*) was found in two nurseries and should meet with more popularity on account of its attractive foliage, its shapely head, its hardiness, and the fact that none had been attacked by Dothichiza. Some inoculations were made by Mr. F. M. Trimble of the Pennsylvania Bureau of Economic Zoölogy, to test the immunity of this tree. The results of these inoculations will be of interest this coming spring. If any conclusions can be drawn regarding the relative susceptibility of the various species of poplar attacked, they would receive the most support from a comparison of the number of diseased trees of each species, and the relative virulence of the attacks. That the Lombardy poplar is the most susceptible seems borne out by the fact that this species has the greatest percentage of infected trees. The degree of virulence is fully as great, however, in all of the other species subject to the canker, with the exception, perhaps, of the Carolina poplar. The latter species was able to produce such a vigorous growth of cambium that in most cases the wounds produced by the canker were entirely healed over. On the other hand, where heavy pruning offered many wounds on the trunk for the entrance of the spores from which cankers developed, the trees were unable to overcome the injuries.

Nurserymen have noted cankers on Lombardy poplars for several years, and estimates ranged from three to thirty years. No serious affection among poplars was reported, however, until 1915, when "a badly diseased condition of black poplars was reported to the U. S. Department of Agriculture. In the spring of 1916 numerous complaints were received of a serious blight on freshly transplanted black poplars."[1] The presence of *Dothichiza populea* was found to be

[1] Hedgcock, Geo. C. and Hunt, N. Rex. *Dothichiza populea* in the United States. Mycologia, vol. VIII: 300–308.

responsible in each case. The indications are that the fungous has been present much longer than these first reports would indicate. Whether the cankers produced on Lombardy poplars thirty years ago, as stated by two nurserymen of this state, were produced by Dothichiza, is very doubtful. Other canker-producing fungi are quite common on both poplars and willows, while *Schizoneura transversitatis* sometimes induces a condition almost identical with a healed over canker.

The typical injury from the poplar canker results directly from the death of the cambium in the infected area. Unless a canker completely encircles the trunk, the tree may live for several years and even when badly attacked by a number of cankers, there is often sufficient vigor left for new growth to be produced and for maintaining a scarred and unsightly existence. Each year the dead branches become more numerous and conspicuous, the beautiful spire-shaped outline of the tree is destroyed, unsightly water sprouts form below the cankered areas, the dry leaves hang on late in the fall and the trunk is likely to be snapped in two by slight wind storms. Again the whole top of the tree may be killed immediately by an encircling canker and oftentimes the whole tree. If the outer bark is stripped from a badly diseased tree, the irregular brown colored areas where the cambium has been killed are readily seen. Cankers often form at the base of the lateral branches and one after another the branches become infected and die.

The cankers first appear as depressed and slightly darker areas of bark, their greatest dimension usually parallel with the axis of the trunk or branch. They are usually tapering at the ends and may occur anywhere on trunk or limb but in most cases about the base of branches or twigs or where conspicuous wounds have been made. As the canker becomes older it may cover quite an extensive and irregular area. One canker mentioned by Hedgcock and Hunt, was twelve inches long and encircled the trunk of the tree for nearly two-thirds the length of the canker. Incipient cankers have been found by the writer in the wounds made by the egg punctures of the Buffalo tree-hopper. It is also significant that in a block of balsam poplars which were seriously infested by the poplar weevil (*Cryptorhynchus lapathi*), every tree so infested was also badly cankered, while some Lombardy poplars in a block adjacent and not attacked by the weevil were correspondingly free from the canker.

Soon after the development of the sunken areas, in April and May, numerous pustules or blisters push up from beneath the bark. These rupture in a short time and a sticky, amber-colored mass of spores exude, which dry up a month later and assume a darker walnut brown

color. These masses of spores, being in a sticky mass, at first might readily be carried by mammals, birds, or insects, and later when they have dried, are disseminated by the wind. After June the course of the disease is arrested until the following spring, wherein it is unlike the chestnut blight (*Endothia parasitica*), although in April or May these diseases have such points of similarity as the yellow exuding mass of spores, the erumpent pycnidia, and the sunken areas of diseased bark.

Affected trees at once attempt to repair the wound and by July and August may have progressed so far as to entirely cover the open wound with a growth of cambium, which in such cases forms a knot of varying size. In every case where this is cut into, the dead area caused by the canker is easily exposed. The disease continues to progress the following year, although apparently healed over after the first attack. Where trees have been weakened year after year by attacks of the canker, they become unable to counteract the disease by a fresh growth of cambium. Large unhealed cracks and fissures remain in the bark and the tree soon dies.

Dothichiza populea was first described and named in 1884 by Saccardo and Briard. In 1903 Delacroix ascertained that the fungus was parasitic in nature and was the cause of a serious disease attacking *Populus nigra, P. deltoides* and *P. bolleana*. Hedgcock and Hunt of the Bureau of Plant Industry have made the most extensive studies of this and other poplar diseases in the United States and have contributed the only literature on the subject in this country, consisting of a short paper in vol. VIII of *Mycologia* for November, 1916. These writers conclude that the disease was probably imported on nursery stock previous to the enforcement of the present inspection laws and that it is a somewhat recent disease in the United States.

The disease was by no means confined to nurseries. The trees in private estates in many cases were seriously attacked, and very few of the trees along roadsides or the railroad right of way had escaped it. A systematic course has been pursued with reference to the disease in nurseries of this state. All blocks of poplar have been carefully examined and diseased trees have been marked for removal. The various nurseries have coöperated cheerfully in this destruction of cankered trees. This treatment has been severe, but no other means of control could be more efficient. In the only nursery of the eastern section of the state which had poplars entirely free from the canker, the trees were regularly sprayed every winter with lime sulphur. In no other nursery had the poplar trees been sprayed. This would indicate lime sulphur as a helpful fungicide. Landscape architects now specify that Lombardy poplar trees must be branched from the

base up, while heretofore the basal branches have been cut off close to the trunk. This will doubtless have the effect of decreasing the disease. It seems wise to recommend that poplar trees should not be pruned to any great extent in any part. Poplar trees should have good drainage and proper precautions should be exercised against the use of cuttings from diseased trees. In blocks of poplars growing on lowlands the virulency of the disease was greater.

The utility of the Lombardy poplar for screening unsightly objects or for giving accent to an otherwise monotonous group of trees or shrubs is recognized by nurserymen and landscape architects. Its popularity as a tree for framing in a view is not questioned and they are often very effective for planting close against houses, particularly of the English style. While no other substitutes could fill all the conditions desirable in trees of this type, there are several trees of similar habit and more permanent beauty. The maiden-hair tree (*Gingko biloba*), the Katsura tree (*Cercidiphyllum japonicum*) and the pyramidal varieties of sugar maple, English oak and the tulip tree comprise a list which should suggest a worthy substitute in case the poplar canker does not prove amenable to treatment.

IS CROWN GALL INJURIOUS TO APPLE NURSERY STOCK?

By S. B. FRACKER, *Assistant Entomologist, Madison, Wis.*

Under Wisconsin conditions the presence of crown gall and hairy root on apple trees is the cause of a greater commercial loss to the nurseryman than any other disease. The toll taken by the required destruction of all trees infected with it is very heavy. At the same time there is a real doubt in the minds of the nursery proprietors as to the serious or injurious nature of the trouble.

This doubt is increased by the published results of experimental plantings in New York,[1] by the opinion expressed in a U. S. Department of Agriculture bulletin[2] that the effects of crown gall have been greatly exaggerated, and by the fairly well advertised presence in a neighboring state of a flourishing orchard planted entirely with trees bearing large galls.

The writer, therefore, during the last autumn packing house inspection seized the opportunity of making some observations in regard to the relative size of infected and non-infected nursery trees. In all cases the grading into sizes was done by the nurseryman himself and

[1] F. C. Stewart, N. Y. Ag. Exp. Sta. Bul. 328 (1910), pp. 311, 312.
[2] Hedgcock, U. S. Bur. Plant Ind. Bul. 186 (1910), p. 72.

the determination of the presence of crown gall made by the author. All indications of an infection were included, although a small gall or one on a lateral root does not cause the tree to be condemned under our present regulations.

Observations were made in four nurseries, two of which use three grades in addition to culls and two admit only two grades. In all cases the lowest size above the culls is sold for a very low price—below cost of production—while all the profit must be made on trees of the first or first and second grades as the case may be. Consequently, in the following figures the culls and lowest grade trees are added together.

In the two nurseries using three grades, a total of 596 trees (chosen at random, "nursery run") were classified as to infection and size. Three varieties were used—Duchess, Fameuse, and Transcendent crab—with results as follows:

	Number Ones		Number Twos		Threes and Culls		Per Cent Ones and Twos	Total
	No.	%	No.	%	No.	%		
Clean	229	65.1	49	13.9	74	21.0	79.0	352
Infected	92	37.7	77	31.6	75	30.7	69.3	244
Totals	321	...	126	...	149	...	...	596
Superiority of non-infected trees	...	27.4%	...	...	...	...	9.7%	...

This table indicates that out of 1,000 trees not infected with crown gall the nursery might expect 651 trees of the first grade and 139 of the second, a total of 790 trees which would pay the cost of production. In 1,000 infected trees, however, only 377 would be first grade, 316 second, a total of only 693 trees which would pay for raising. If we assume that the best apple trees are worth ten cents apiece wholesale and that the "seconds" are worth three-fourths as much as the "firsts" the value of 1,000 non-infected trees would be $\$65.10+(\frac{3}{4}\times\$13.90)=\$75.52$. One thousand infected trees, if allowed to be sold, would be worth $\$37.70+(\frac{3}{4}\times\$31.60)=\$61.40$, a reduction of 18.7 per cent in value.

In one of the nurseries selling only *one* grade of trees at a profit the figures, mainly for Duchess, are as follows:

	Number Ones	Seconds and Culls	Totals	Per Cent Number Ones
Clean	147	58	205	71.7
Infected	125	86	211	59.2

In this case infection in the 416 trees examined apparently reduced the profitable trees from 717 per thousand to 592 per thousand, a reduction of 17.4 per cent in value.

The fourth nursery usually has so few infected trees that the method employed in the others was scarcely available here. In one variety of their own production, however, which they had been careless in grafting, between 50 and 60 per cent of the "seconds" proved to be infected with crown gall but only about 10 per cent of the "firsts."

Summary

In the first three nurseries discussed, 1,012 apple nursery trees were examined for crown gall and hairy root and graded into sizes. They indicate that the infected trees, if their sale was permitted, would yield 17 to 18 per cent less gross return to the nursery than a similar number of non-infected trees. This is in spite of the fact that the largest of the infected trees were usually as large and apparently as strong as the non-infected ones. In taking the figures the separate nurseries and varieties were tabulated separately and not a single nursery or variety shows as great a proportion of trees of salable size among those with crown gall as in those without the disease.

An interesting point in connection with the inspection at the first two nurseries, both of which make a practice of providing their customers with two grades of stock, was the great diminution in the number of first grade trees when infected and the increased number of seconds. In many cases there seemed to be a tendency for the infection to decrease the vigor of the plant without severely forcing its size down below commercial value.

The correlation between small size and infection might be said to be due to a possible greater susceptibility of weak trees. Phytopathologists, however, state that the reverse is true and only strong actively growing tissue will support the disease. In view of the marked deleterious effects of crown gall in the irrigated orchards of the west, it seems most likely that this reduction in size in Wisconsin nurseries is a direct result of infection.

(Papers read by title)

STUDIES ON THE LIFE-HISTORY OF TWO KANSAS SCARABÆIDÆ (COLEOP.)[1]

By Wm. P. Hayes, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

Introduction

The study of the two species under consideration, *Cyclocephala villosa* Burm. and *Anomala binotata* Gyll., is a continuation of the life-history investigations of Kansas white grubs. The synonymical status of *Cyclocephala villosa* Burm. is in question because of its similarity to *Cyclocephala immaculata* Oliv. In a large series of specimens, intermediate forms show a gradation from one species to the other. Horn (1871, p. 337) separated *C. villosa* from the synonymy of *Melolontha angularis* Knoch where it had been previously placed. If *C. immaculata* and *C. villosa* are found to be synonymous, *immaculata* should take precedence because of priority. However, the writer chooses to call the species *villosa*[2] on the authority of Swenk (1911, p. 285) who states that *villosa* is the most abundant species in Nebraska, an adjoining state.

With *Anomala binotata* Gyll., three species, *unifasciata* Say, *marginella* Lec., and *luteipennis* Lec., have been united by Horn (1884, p. 164), the latter being a variety with the elytra not as rough, more shiny and without the usual spots.

Cyclocephala villosa Burm.

General Considerations.—The genus *Cyclocephala* contains some of our common and most injurious white grubs. Forbes (1891b, p. 40) reports the grubs of *C. immaculata* infesting grass-land, corn on sod, roots of corn, and young oats. Titus (1905, p. 14) found them at the roots of grass and sugar-cane stubble, and Riley (1870, p. 307) recorded them in strawberry beds. Davis (1916, p. 264) states: "*Cyclocephala immaculata* is frequently found in compost heaps and in cultivated fields, and may obtain its full growth on decaying matter alone or may become a serious field pest, damaging crops similar to those attacked by *Lachnosterna* grubs." Under the name *C. villosa*,

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[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 31. This paper embodies the results of some of the investigations undertaken by the author in the prosecution of project No. 100 of the Kansas Agricultural Experiment Station.

[2] Specimens sent to J. J. Davis were determined as *Cyclocephala villosa* Burm.

Swenk (1913, pp. 86–87) reports the larvæ doing severe damage to winter wheat in Nebraska. He says: "The same condition was common in many fields in the southeastern part of the country, namely, that the plants had commenced dying about the first of September and in the next month had died out completely or at least had only a scattered sickly stand remaining. The soil in these fields was fairly alive with the *Cyclocephala* larvæ. Over fifty were turned out in a space less than two feet square and not all of them were secured." The writer has taken the grubs in corn, wheat, and oat fields, in grass of lawns, and sod of orchard and pasture land. Meager accounts are found in the literature of the life-history of *C. immaculata*. The following observations on *C. villosa* were made in Kansas during the past two seasons:

THE EGG.—The eggs are pearly white and nearly round, being slightly longer than wide. When freshly laid, they are about 1.2 mm. wide and 1.7 mm. long. They continue to increase in size as development proceeds, but gradually lose their oval shape until a nearly round form is assumed, at which time they are about 2.1 mm. in diameter. An average measurement of thirty eggs, chosen at random from eggs of various stages of growth, was found to be 1.7 mm. wide and 1.95 mm. long. Eggs are laid in the ground, generally in small clumps of soil. The exact number of eggs laid by an individual female has not been definitely determined. Three females, mated in rearing cages, afterwards laid 21, 16, and 10 eggs apiece. In each case, these females had been collected at lights and may have mated and laid eggs previously. Table I shows the number and time of egg laying by these individuals, and the interval between mating and oviposition.

TABLE I—OVIPOSITION RECORD

No.	Date Mated	Number of Eggs Laid							Number of Days between Mating and Oviposition
		July 18	July 21	July 24	July 29	Aug. 3	Aug. 5	Total	
1	July 5	..	6	4	..	..	..	10	16
2	July 12	..	8	3	5	..	..	16	9
3	July 12	3	2	..	4	10	2	21	6

In life-history cages, egg laying by females collected at lights began, in 1916, on July 3, and, in 1917, on July 11. In each instance, the period of oviposition extended over 31 and 44 days, respectively. Individuals becoming adults after July 20, 1917, began to lay eggs August 1, 1917. Table II shows the variation in the length of the egg stage for the two seasons.

THE LARVA.—Previous to hatching, the body segments and the brown mandibles of the young larva can be discerned through the

TABLE II—INCUBATION PERIOD

Date	No. Eggs Hatching	Minimum Days	Maximum Days	Average Days
1916	51	9	23	13
1917	56	13	25	18

shell of the egg. When hatched, the grub is about 2 mm. long and, except for the mandibles, is entirely white. In a few hours the entire head begins to darken until it has assumed its final brownish color. The grubs when full grown are about 23 mm. long and 6 mm. through their widest part, and are creamy white in color. In their characteristic doubled-over position, they appear about one-half as long or about 12 mm.

The grubs of this genus are distinguished from those of *Lachnosterna* by the absence of the median longitudinal double row of mesad pointing spines on the last abdominal segment of *Lachnosterna* and by a transverse anal slit which in *Lachnosterna* is V-shaped. According to Davis (1916, p. 266) the *Cyclocephala* grubs resemble those of *Cotalpa*, with which they are more apt to be confused.

As the time of pupation approaches, the grubs shed the meconial mass in their alimentary tract and appear to shrivel up somewhat, cease feeding, and become generally inactive, forming the prepupal stage. Table III gives the length of the complete larval stage as it occurs in Kansas.

TABLE III—DEVELOPMENT OF GRUBS FROM HATCHING TO PUPATION

Serial No.	Hatched	Became Prepupa	Pupated	Length of Prepupal Stage (days)	Complete Time of development (days)
	1916	1917	1917		
1895	July 15	June 23	June 30	7	350
1896	July 15	June 26	July 1	5	351
1898	July 16	July 6	July 12	6	361
1899	July 16	June 28	July 5	7	354
1902	July 16	June 27	July 5	8	354
1903	July 17	July 10	July 16	6	364
2246	July 22	July 5	July 11	6	354
2247	July 22	June 28	July 5	7	348
2356	July 23	June 26	July 5	9	347
2361	July 24	June 26	July 1	5	342
2945	July 27	June 23	July 1	8	339
3036	Aug. 1	July 1	July 8	7	341
3038	Aug. 1	June 26	July 5	9	338
3040	Aug. 2	June 30	July 7	7	339
3041	Aug. 2	June 26	July 3	7	335
3042	Aug. 2	July 7	July 13	6	345
3083	Aug. 2	July 9	July 16	7	348
				Average 6	347

The average time of complete development for 17 individuals was 347 days, with a minimum of 335 days and a maximum of 364 days. The prepupal stage has an average length of 6 days, with a minimum

of 5 days and a maximum of 9 days. In 1916, the first larvæ hatched July 15 and, in 1917, July 24. The winter is passed as a larva and the following summer the grubs transform to pupæ. Grubs were fed from the time of hatching to the prepupal stage on germinating grains of wheat, except during the winter when they were in a dormant condition. The larvæ were found infesting corn, wheat, and oat fields, as well as sod of lawns, orchards and pastures.

THE PUPA.—The pupa is about 17 mm. long and 8 mm. wide. When freshly transformed, it is creamy white with a faint trace of brown on the legs, wings, head, thorax, and tip of abdomen. Gradually, the pupa darkens to a reddish brown. It lies, as a rule, in the old larval moult which splits at the time of pupation from the epicranial suture backwards over the dorsum of the grub.

In 1916, pupation began in soil cages on May 27 and continued until the middle of July. In 1917, pupation did not begin until June 30, and lasted until August 6. Pupæ were collected in the fields during late June, checking closely with the time of pupation in life-history cages. Table IV gives the length of the pupal period of 13 individuals reared from eggs.

TABLE IV—LENGTH OF PUPAL STAGE

Serial No.	Pupated	Became Adult	Length of Stage	Sex
	1917	1917		
1895	June 30	July 21	21	♂
1896	July 1	July 21	20	♂
1899	July 5	July 23	18	♂
1902	July 5	July 22	17	♂
2246	July 11	July 27	16	♀
2356	July 5	July 21	16	♂
2361	July 1	July 20	19	♂
3036	July 8	July 26	18	♂
3038	July 5	July 23	18	♂
3040	July 7	July 25	18	♂
3041	July 3	July 22	19	♂
3042	July 13	July 28	15	♀
3083	July 16	Aug. 2	17	♂
			Average 17	

The average time of development was 17 days, with a minimum of 15 days and a maximum of 21 days. The average of 33 other individuals reared from grubs collected in the fields was 16 days, with a minimum of 8 days and a maximum of 24 days.

THE ADULT.—Newly emerged adults have a pale creamy tinge which soon darkens to a normal dull yellow color. They are from 11 to 14 mm. long and 6.8 mm. wide and have the surface sparsely covered with fine hairs. The elytra and thorax are somewhat finely punctuate. Males are distinguished from the females by an enlargement of the fifth joint of the anterior tarsi and a somewhat longer antennal club.

The adults fly at night and are strongly attracted to lights. The

first appearance of the beetles at lights was June 12, in 1916, and June 29, 1917. In the first instance, a maximum flight was reached near the last of June, while, in 1917, the maximum was attained near the middle of July. The flight during both years extended to near the middle of August. Mating takes place in the daytime and in life-history cages was several times observed on the surface of the soil. The male uses the enlarged tarsal joint to clasp the female on the edge of the elytra behind the legs. Unlike the position assumed in *Lachnosterna*, the females of *villosa* do not remain motionless but will move about carrying the males on their backs. If disturbed while mating, they hasten to burrow into the soil. The food of the adults has not been definitely determined. None were taken on trees among daily collections made last summer. A few individuals were collected at night on the common pigweed (*Amaranthus* sp.) upon which they were apparently feeding.

To summarize, the life cycle of *C. villosa* is one year. Adults appear at lights in June, July, and early August. Eggs, which are laid in soil, hatch after 9 to 25 days. The larva passes the winter in hibernation. The larval stage was found to average 347 days. The pupal stage varied in length from 8 to 24 days.

Anomala binotata Gyll.

General Considerations.—In the adult stage, this species is known as a leaf-eater. In the grub stage, its depredations are not so familiar. However, they are thought to feed on living rootlets (Davis, 1916, p. 265) and may often occur in sufficiently large numbers to damage crops. Webster (1891, pp. 345–346) records adults feeding on strawberry blossoms and later (1892, p. 197) on blossoms of blackberries in large numbers. He also cites an instance of a fly (*Laphria tergissa*) capturing and flying away with a beetle of this species in its grasp. Lugger (1899, p. 175) lists *binotata* in his work on insects injurious to fruit-producing plants. Johnson (1900, p. 84) records three instances of the beetle feeding on foliage of pear and apple trees. Chittenden (1902, p. 100) states that *binotata* is one of the vine-chafers injurious to grapes, strawberries, and locust, and later (1903, p. 732) adds that they were injurious to roses in 1902. Pettit (1908, p. 122) recommends spraying with arsenites after having found the beetles injuring young apple foliage. Hart (1911, pp. 73–75) records more observations on this species than any American writer. He noted from 30 fields in which pupæ and adults were found, 29 of them had been in oats. A note before the writer shows that out of 126 beetles maturing from larvæ collected in fields, 115 individuals were taken in oat fields. The remainder were from wheat and corn land. Felt

(1913, p. 106) found the beetles in strawberries being shipped into New York, and Swenk (1913, p. 87) mentions the insect as a minor wheat pest in Nebraska where he found them in large swarms alighting on wheat and trees and shrubs of all kinds.

THE EGG.—The eggs of this species are pearly white and have a distinct shining luster. They are slightly longer than wide, being somewhat oval in appearance. When freshly laid, they are about 1.6 mm. long and 1.2 mm. wide. As development progresses, the eggs increase in size until they attain an average size of about 2.5 mm. long and 2.0 mm. wide. Oviposition occurs during the early part of June, the eggs being laid in the soil. A number of eggs found in life-history cages on June 15, but which had been laid some few days previous, hatched from 7 to 11 days later. Shortly before hatching, the brown tips of the mandibles and faint outlines of the body of the embryo larva can be seen through the egg shell.

THE LARVA.—The young larvæ upon hatching are about 2.5 mm. long and are entirely white except for the tips of the mandibles which are brown. When full-grown, they are about 20 mm. long and 7 mm. wide at the thorax. They taper toward the posterior end and are creamy white with a pale yellow, finely reticulated head. The spiracles are likewise pale yellow in color. The posterior ventral segment bears a triangular patch of short hairs with a centrally located longitudinal double row of prostrate spines. Dorsally, this particular segment bears longer and much finer hairs. The other dorsal segments are covered with short, brownish, bristle-like hairs interspersed with finer and longer hairs. Concerning these grubs Davis (1916, p. 266) writes: "The grubs of *Anomala*, *Listochelus*, and *Phytalis* are very close to those of *Lachnosterna* and we are at present unable to satisfactorily distinguish between grubs of these four genera except by direct comparison, but no doubt substantial characters will be found when we have obtained a sufficient number of grubs of the first three mentioned genera." The first larvæ hatched on June 22. The length of the larval stage, inclusive of the semi-pupal stage, was found to average 83 days, with a minimum of 80 days and a maximum of 86 days.

When near pupation the grubs shed their meconium and appear to become shorter and broader. This is the initiation of the so-called prepupal stage. Faint traces of black waste matter are still to be see in the alimentary tract. The posterior abdominal segment appears much depressed and greatly wrinkled. This condition is likewise found to a lesser degree in the penultimate segment. The prepupa lies coiled on its back and when disturbed wriggles about on its side, alternately straightening and coiling the body. The length of the prepupal stage varies from 6 to 10 days with an average of 7 days.

Grubs were reared from the egg to prepupa in common salve boxes by feeding them germinating grains of wheat, the roots of which apparently offered sufficient sustenance. Larvæ were collected abundantly in oat land and doubtlessly fed upon the roots of oats. They were also found in wheat and corn fields but not in such large numbers.

THE PUPA.—The transformation from the larva to the pupa leaves the newly formed individual, as a rule, within the old larval moult from which it has just emerged. At first it is creamy white but soon changes to a dark yellow until just before the end of the period the head, thorax, wings, legs, and last abdominal segments assume a still darker hue. The pupæ are from 14 to 16 mm. long and from 6 to 7 mm. wide. Movement results from raising and lowering the abdomen. They are easily distinguished from the pupæ of *Lachnosterna* by the absence of the long protuberances at the tip of the abdomen and their much smaller size. In life-history cages, pupæ were collected as early as August 24, but the majority of the individuals were found soon after September 1 and continued to be present throughout the entire month. Pupæ collected in the fields during the month of September served as a check on the cage observations. The average length of the pupal stage for 126 individuals was 16 days, with a minimum of 13 days and a maximum of 22 days.

THE ADULT.—Horn (1884, p. 158) describes *Anomala binotata* as follows:

"Form moderately robust, piceous; thorax dark bronze, shining; elytra yellowish testaceous, the suture and margin narrowly bordered, and usually on each side two piceous spots. Head rather densely punctured. Clypeus scarcely broader at base, the margin narrowly reflexed. Thorax narrowed in front; sides arcuate, disc convex, sparingly punctured, toward the sides more densely and with a larger foveate puncture. Scutellum bronzed. Elytra, with striæ, of coarse punctures, somewhat confused in the sutural region, three of the intervals very slightly more elevated. Pygidium rather densely rugulose, and with short hairs. Body beneath coarsely, not densely punctured, pectus, coxal plates and sides of abdomen hairy. Length .40–.44 inch; 10–11 mm.

"The claw joint of the anterior tarsi is distinctly toothed beneath. The anterior claw is flexed at base, the tip cleft, the upper portion quite slender, and a little shorter than the lower. The anterior claw of the middle tarsus is cleft at tip, the two portions nearly equal."

The adults of this species are notably injurious to the blossoms and foliage of fruit-producing plants. They fly by day, often at dusk and infrequently at night, being attracted to lights. They begin to mature by September 6 but remain in their pupal cells until the following spring. According to Hart (1911, p. 73) mating occurs on the surface of the soil where the females attract the males, after which the females enter vertical burrows in the soil presumably to deposit eggs. Males can be distinguished from the females by the antennal club which is

longer than the funiculus in the male and about equal in length to the funiculus in the female.

Birds are known to feed on the adults of this species. McAtee (1908, pp. 26 and 44) reports cardinals and rose-breasted grosbeaks feeding on *Anomala binotata* and Beal (1912, pp. 17 and 54) cites the kingbird and yellow-bellied fly catcher. The writer found one specimen in the stomach of a toad taken in a corn field in May.

To summarize, the adults of *Anomala binotata* are injurious to fruit-producing plants and the grubs are minor pests of corn, wheat and oats. The winter is passed as an adult. Eggs are laid in the spring and soon hatch, producing larvæ whose average time of development was found to be 83 days. The pupal stage lasts on an average 16 days. The adults transform in the fall and remain in their pupal cells until the following spring, thus completing a one-year life cycle.

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NOTES ON THREE SPECIES OF APPLE LEAF-HOPPERS

By Frank H. Lathrop, *Assistant Entomologist, Oregon Agricultural Experiment Station*

While connected with the New York (Geneva) Agricultural Experiment Station the writer had opportunity to make observations on the life-histories and habits of three important leaf-hoppers attacking apple.

The three species of leaf-hoppers, *Empoasca mali* LeBaron, *Empoasca unicolor* Gillette, and *Empoa rosæ* Linnæus, which are discussed in this paper, are quite similar in general appearance. Especially is this true of the two species of Empoasca and the nymphs of all three species.

Distinguishing Characteristics

The nymph of *Empoa rosæ* may be distinguished by its white color, as well as by the contour of the anterior margin of the vertex. The

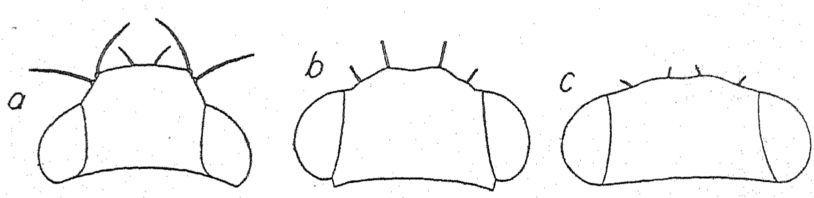

Fig. 5. Heads of leaf-hopper nymphs, showing comparative structures and sizes; *a*, *Empoa rosæ*, *b*, *Empoasca mali*, *c*, *Empoasca unicolor*.

nymphs of both the other species are green, and by this character may be separated from the preceding form with little difficulty. The two Empoasca nymphs are very closely similar, and are very easily confused. The nymph of *Empoasca unicolor* differs most distinctly from that of *E. mali* in the contour of the anterior margin of the vertex and there is also a difference in the coloration of the two species.

The adult of *Empoa rosæ*, like the nymph, is recognized by its white

or whitish color. The adult of *Empoasca unicolor* is larger and a trifle more robust than that of *E. mali* and the coloration of the two is quite distinct. However, the most reliable distinctive characteristics are the form of the female genitalia and the contour of the anterior margin of the vertex.

Seasonal Activities

During the summer and fall of 1915 the district of western New York about Geneva experienced a heavy infestation of the apple leaf-hopper, *Empoasca mali.* The foliage of apples in nursery plantings and of young orchard trees was severely curled. Similar injury was commonly observed on various ornamental nursery stock, and the writer's attention was especially attracted by the injury to Norway maple and cut leaf birch. During this season infestation by *Empoa rosæ* was also quite common, and their attacks were in evidence in all orchards observed. *Empoasca unicolor*, on the other hand, seemed to be comparatively rare, and no cases of heavy infestation were observed.

The season of 1916 was fully two weeks later than normal, and there was a consequent delay in the beginning of insect activities. During the spring and summer of this season conditions were somewhat reversed with respect to leaf-hopper abundance. *Empoasca mali*, though still decidedly injurious, was much less in evidence than during the preceding season, while *Empoasca unicolor* was exceedingly plentiful, proving to be a true pest and by far outnumbering *E. mali. Empoa rosæ* was again prevalent, and, in spite of its natural enemies, did considerable injury.

Life-History Studies

Empoa rosæ. This species spends the winter in the egg stage. By far the larger number of the winter eggs are deposited in the bark of the rose although a few occur on apple.

On May 20, nymphs were found emerging from eggs on rose. The young nymphs immediately migrated to the underside of the leaves and began feeding. The hatching of nearly all of the eggs occurred almost simultaneously, and within a few days all of the nymphs had apparently emerged. The nymphs were common on roses, and many cases of very heavy infestation were observed. The apple, on the contrary, was almost entirely free of infestation, and only occasional nymphs of this generation could be found on this plant.

The first adults of the season appeared during the second week in June, and from that time on, the number of adults increased, until, by the latter part of the month, practically all the nymphs had transformed. The adults migrated to apple, and after this, the rose was almost deserted. After the middle of July the adults began to decrease

noticeably, and by the latter part of the month had become comparatively rare.

After migration, the eggs were deposited on apple. Nymphs of the second generation appeared during the middle of July, and during early August the adults of this generation occurred in numbers. The nymphs of the second generation reached their greatest abundance during the last week of July and the first week in August. From this time on, the nymphs became less numerous, and by early October, had become rare, although at this time the adults were numerous on apple.

Migration now occurred from the apple to the rose, where the winter eggs were deposited.

Empoasca mali. The observations made at Geneva during this study show that this species hibernated largely, if not exclusively, in the adult form. During the winter, three dozen one- and two-year-old

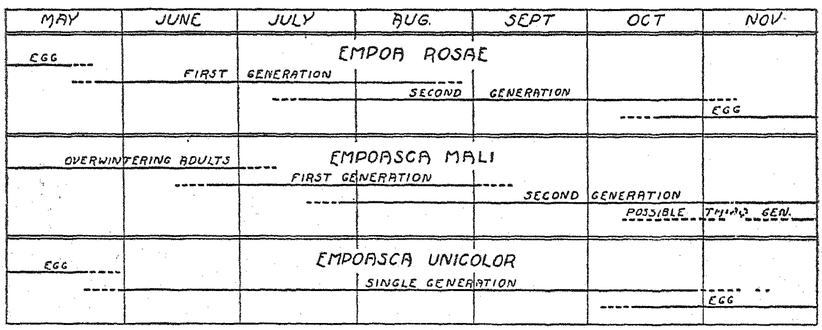

Fig. 6. Life-cycles of apple leaf-hoppers as observed at Geneva, New York, during the seasons of 1915 and 1916.

apple stock were planted in the greenhouse. Numbers of leaf-hopper nymphs soon emerged from eggs deposited in the bark. The appearance of the nymphs was such that they might easily have been mistaken for *Empoasca mali*, but when the adults developed, they proved without exception to be *Empoasca unicolor*. No nymphs of the former species appeared.

In the orchards, nymphs of *E. mali* appeared in numbers during the last ten days in June. This is obviously too early for the appearance of nymphs of the second generation, and is much too late for the hatching of the winter egg, had hibernation taken place in that stage.

There was considerable variation in the ages of the nymphs of this first generation, and the more advanced matured in early July. By the middle of July, the great majority of the nymphs were in the later instars and the adults were becoming very numerous. Nymphs of the second generation began to appear during the latter part of the month,

but the increase in the numbers of adults was more rapid than the increase in the numbers of the nymphs, so that during early August, the adult was the greatly predominating form. During the first half of August nymphs of the second generation gained the ascendency, and it was during this period that the earliest adults of the second generation appeared. By late September adults were very abundant, and most of the nymphs were of the later instars. However, all stages of the insect continued to be present until frosts killed the remaining nymphs. It seems quite probable that these nymphs which emerged so late in the season represented a third generation from eggs deposited by the more precocious adults of the second generation. It is doubtful if any of these reached maturity and were able to pass the winter. No evidence of oviposition in the bark of the infested trees could be found.

Empoasca unicolor. This species spends the winter in the egg stage. The hatching occurred somewhat later than that of *Empoa rosæ* and nymphs appeared during the last week in May. Development was slow as compared with the other species under observation, and adults did not appear until the first week in July. By the middle of the month all of the nymphs had matured. The insect is single brooded, and no eggs were observed until late fall, when the overwintering eggs are deposited in the bark of the apple.

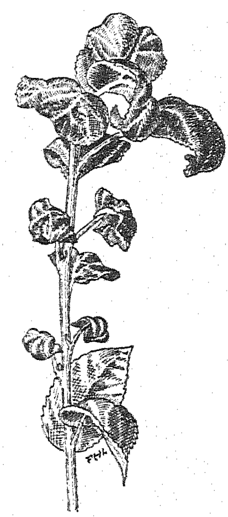

Fig. 7. Typical injury to apple by *Empoasca mali*.

Habits and Nature of Injury

When living on the apple, *Empoasca mali* is found feeding almost exclusively on the tender terminal growth, and it is for this reason, perhaps, that the species shows a marked preference for young, growing trees. *Empoa rosæ* and *Empoasca unicolor* both confine themselves very largely to the older leaves, although they occur on both old and young trees. However it was noticed that *Empoa rosæ* was more prevalent on the older trees, while *Empoasca unicolor* was most abundant on younger trees.

The attack of *Empoasca mali* causes a severe and characteristic curling of the foliage and resultant injury to the tree. Both of the other species destroy the chlorophyl of the leaves, with a consequent reduction of their value to the tree.

Fire Blight Transmission

A series of experiments was undertaken to determine the possibility

of the transmission of fire blight by these insects. Rapidly growing two-year-old apple shoots in the greenhouse were infected with the organism obtained from exudate from infected twigs in the orchard. These shoots were enclosed in fine netting bags, and when the disease had developed, the leaf-hoppers were introduced. After feeding for from several hours to a day, the insects were transferred to healthy shoots and allowed to feed.

The results may be briefly summarized as follows:

Expt. No. 1.	Five adults *Empoasca unicolor*	Negative
Expt. No. 2.	Two adults *E. unicolor*	Doubtful
Expt. No. 3.	Fourteen nymphs *E. mali*	Positive
Expt. No. 4.	One adult *E. unicolor*	Negative
Expt. No. 5.	Two nymphs *E. mali*	Negative
Expt. No. 6.	Six nymphs *E. mali*	Positive
Expt. No. 7.	Ten nymphs *Empoa rosæ*	Negative
Expt. No. 8.	Ten nymphs *Empoasca mali*	Positive
Expt. No. 9.	Five nymphs *E. mali*	Negative
Expt. No. 10.	Two adults *E. unicolor*	Negative

Of the five transfers of the nymphs of *E. mali*, three gave positive results. The tests with adults of *E. unicolor* were negative, except in one case which was doubtful. The test with *Empoa rosæ* resulted negatively. The negative results should not be taken to indicate that these species are incapable of transmitting the disease.

IMPORTANT NOTICE

At the Pittsburgh meeting of the Association it was voted that the Secretary be instructed to prepare an Honor Roll of the members of the Association who are in the United States or allied service.

In order to do this and secure an accurate record, it is necessary to have the fullest coöperation of the members. It is requested that each member send to the undersigned as soon as possible the records of any members of the Association who are in the services above mentioned, with as much detail as possible as to their rank and the regiment or other military unit to which they are attached.

A. F. Burgess,
Secretary.

Scientific Notes

Eriophyes ramosus n. sp. An interesting infestation by eriophyid mites was brought to my attention by Dr. E. P. Felt on a specimen of *Juniperus pachyphlœa* from Williams, Arizona. The juniper was received from Prof. E. Bethel, State Museum, Denver, Colorado.

The twig bore several large, more or less deformed, infertile fruits. On the surface of each were several minute circular openings. Upon dissection, the berries were found to be literally alive with the mites which had entirely destroyed the inner cellular structures. In some of the fruits the creatures were so abundant that their bodies entirely filled the cavity.

A similar injury has been mentioned by Dr. A. Nalepa on *Juniperus communis* L. in Europe and is said to be caused by *E. quadrisetus typicus* (F. Thom.). The American form differs in several respects from the foregoing species and may be recognized by the following characters:

The body is small, cylindrical, uniform in width, and very long. Length 231μ, width 59μ.

The thoracic shield is small, triangular in form and slightly arched. Its lateral margins are gently rounded and partially cover the trochanter. The anterior margin is acuminate and projects over the rostrum, while the posterior margin is gently rounded. The dorsal setæ are longer than the shield, rather fine and are usually directed anteriorly. The setal tubercles are of medium size, nipple like, being situated widely apart near the posterior margin but not projecting beyond. The rostrum is of medium length, stout, strongly curved, and projecting forward and obliquely downward. The rostral bristles are long and stout. The claw is truncate, curved, slightly shorter than the feathered hair which is 9-rayed and very strong.

The thoracic setæ are all present. T. setæ I are very long, and placed at some distance from the anterior end of sternum. T. setæ II are very long, widely separated and situated opposite the inner epimeral angles. T. setæ III are of medium length and situated about midway between the inner and outer epimeral angles.

The *abdomen* is cylindrical, having 72 striæ which are finely punctured along the posterior margin. The dorsum and ventrum are similar in character. The *setæ* are all present. The Lateral setæ are about equal to Ventral setæ I in length; the Genital setæ are of medium length and stout; setæ Ventral I are of medium length, fine and do not appear to overreach setæ Ventral II; setæ Ventral II are longer than the genital setæ; setæ Ventral III are very stout, reaching the ventral lobes. The accessory and caudal setæ are present, each pair being very long and stout. The epigynium is wide, semicircular and has a coarse distinct sculpturing on the epigynial plate.

Superficially these mites may be recognized by a pinkish to dark-red coloration and the great length and narrowness of the body.

H. E. Hodgkiss,
N. Y. Agricultural Experiment Station, Geneva, N. Y.

Nicotine Sulphate an Effective Ovicide for Codling Moth Eggs. Following the remarkable results of F. E. De Sellem[1] of N. Yakima, Washington, with nicotine sulphate as a control for codling moth, experiments have been undertaken seeking to throw additional light on the subject and afford a satisfactory explanation of the

[1] 1916. De Sellem, F. E. Nicotine Sulphate for Codling Moth Control. Ann. Rept. Hort. Dept. N. Yakima for 1916, p. 62.

matter. In addition to the work already reported, a test[1] was made of the ovicidal value of nicotine sulphate for the eggs of codling moth.

On August 31, codling moth eggs deposited on apples were collected in the field. These eggs varied from those recently deposited to those just ready to hatch. The eggs were examined carefully in the laboratory under a binocular and the position of those appearing perfect in every way was indicated on the fruit by drawing a circle about the egg some little distance away with Higgins waterproof ink. The apples were then so cut as to leave the egg uppermost when the apple was laid on a table. The apples were then sprayed by means of a quart hand sprayer, throwing a very fine mist-like spray. The following materials were used:

No. 1—Black Leaf 40, 1–1200.

No. 2—Black Leaf 40, 1–400.

No. 3—Black Leaf 40, 1–1200 plus fish oil soap at the rate of 4 pounds to 100 gallons.

No. 4—Check.

The final count of results was made on September 8 and gave the following:

	Hatched	*Unhatched*	*Total*	*Per Cent Unhatched*
No. 1	7	38	45	84.5
No. 2	9	36	45	80.0
No. 3	0	26	26	100.0
No. 4	19	5	24	20.8

In the case of No. 1, two eggs were parasitized, No. 2, two eggs parasitized, No. 3, three eggs parasitized; the parasites in all cases apparently dead. In the case of No. 4, two of the unhatched eggs appeared infertile.

Nicotine sulphate is an effective ovicide for codling moth eggs. The addition of soap renders it practically perfect in this regard.

A. L. Lovett, *Entomologist,*
Oregon Experiment Station.

MEETING OF OHIO ENTOMOLOGISTS

For some years it has been the custom for the entomologists of Ohio institutions to hold an annual meeting, the main purpose being to correlate the entomological activities of the State. Such meetings are open to active entomologists and students specializing in entomology.

At the recent meeting held in the botany and zoölogy building of the State University, thirty-seven entomologists were present and an excellent program of twenty-two short papers and addresses was rendered.

PACIFIC SLOPE BRANCH

The annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists wil. be held at Pasadena, Calif., March 28, 29 and 30. The gathering last year was a most successful one and the unusual conditions now prevailing justify and demand the utmost from every entomologist. There is nothing better than conference to promote coöperation and efficiency. Geo. P. Weldon, Sacramento, is vice-president for the Section and E. O. Essig, Ventura, secretary.

[1] 1917. Lovett, A. L. Nicotine Sulphate as a Poison for Insects. Jour. Econ. Ent., vol. X, No. 3, p. 333.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1918

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The wastes of civilization, furnishing as they do breeding places for insects and affording numerous opportunities for infection, are a serious menace to human welfare. This was no problem in primitive days. The wandering tribes frequently changed camp sites and all was well. Such a course is impossible now and while modern plumbing has very generally solved or made possible the disposal of the more dangerous wastes from the home, comparatively little has been done for the adequate care of those from the stable. The suggestion of Mr. Cory in the January issue of the Emergency Entomological Service of the United States Department of Agriculture is of more than passing interest. The rapid drying of manure not only reduces weight and prevents insect breeding but renders such material less obnoxious, tends to its more general utilization as a fertilizer, and indirectly it means a marked lessening of the insect menace. Such a process or some modification may not be profitable, judged solely from immediate and tangible returns and yet pay large dividends if due allowance is made for the protection thereby secured from disease. The necessities of the army may result in working out a method which can be applied to city and village conditions. This is one of the practical problems of present day sanitation, and one which should be speedily solved.

The prohibition of the importation of all nursery stock, except what may be imported by the Secretary of Agriculture for experimental and

scientific purposes, is the object of Senate Bill 3344. It has the backing of a number of forestry associations and primarily is an outcome of the chestnut blight and white pine blister rust situation, especially the latter, though the ravages of imported insects have also had a bearing upon the matter. Brief in text, its provisions are sweeping in character, since it prohibits, except as stated above, the importation of "nursery stock," including "all field-grown florists' stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit pits and other seeds of fruit and ornamental trees or shrubs, and other plants and plant products for propagation, except field, vegetable and flower seeds, bedding plants, and other herbaceous plants, bulbs, and roots." The scope of this bill is so broad and the change so great that it should not be allowed to pass until all interests affected have had a chance to study its provisions most carefully and an opportunity to present their side of the case. It vitally affects our extensive horticultural interests and should therefore be given most careful consideration.

Current Notes

Conducted by the Associate Editor

The *Review of Applied Entomology* announces the death of Mr. C. W. Mason, Government Entomologist in Nyasaland.

Miss Anna Wuentz has been appointed graduate assistant in Entomology at the Minnesota Station, beginning January 1, 1918.

The Hawaiian Sugar Planters' Station has a new building which provides fireproof quarters for the entomological collections.

Professor H. A. Morgan represented Tennessee at the meeting of federal food administrators at Washington, D. C., January 9 and 10, 1918.

Dr. J. C. Bradley gave an illustrated lecture on December 19, on "The Okefinoke," before the monthly meeting of the California Academy of Sciences.

Dr. D. L. Crawford of Pomona College, Claremont, Cal., has been appointed professor of Entomology at Hawaii College and has entered upon his duties.

Mr. William D. Kearfott, head of the Kearfott Engineering Company of New York City, and a specialist in the microlepidoptera, died November 13, 1917.

First Lieut. A. H. Jennings, formerly of the Bureau of Entomology, has been ordered to report at Camp Shelby, Hattiesburg, Miss., for duty in the Sanitary Corps.

Mr. R. D. Whitmarsh, assistant entomologist of the Ohio Station, has been commissioned a captain in the Officers' Reserve Corps and assigned to duty at Camp Grant, Rockford, Ill.

Messrs. Leonard S. McLaine and W. H. Brittain of the office of the Dominion Entomologist, Canada, were visitors at the gipsy moth parasite laboratory, Melrose Highlands, Mass., in November.

Mr. W. R. Walton, in charge of cereal crop insect investigations of the Federal Bureau of Entomology, visited the Department of Entomology, Kansas State Agricultural College, on November 1.

A fire at Mount Holyoke College on December 22, 1917, destroyed Lyman Williston Hall, containing the biological science laboratories and museum. All entomological collections were destroyed.

Dr. H. T. Fernald, Amherst, Mass., has resigned as state nursery inspector, a position under the Board of Agriculture which he has held for fifteen years, and his deputy, Mr. R. H. Allen, has been appointed in his place.

Prof. Herbert Osborn of Ohio State University, and Dr. E. D. Ball, state entomologist of Wisconsin, spent several days in Washington, D. C., in November with Mr. E. H. Gibson, examining types of Homoptera at the National Museum.

The program of Sunday afternoon lectures given in the Museum of Golden Gate Park, San Francisco, Cal., included a lecture for December 16, on "The Growth and Transformations of Insects," by Professor E. O. Essig of the University of California.

Mr. T. L. Guyton and Mr. J. R. Stear, graduates of Ohio State University, have been appointed assistants on the entomological staff of the Ohio Experiment Station at Wooster. Last year Mr. Stear was assistant instructor in Entomology, University of Illinois.

Professor H. A. Gossard, entomologist of the Ohio Station, read a paper before the National Nut Growers' Association, Biloxi, Miss., October 10, in answer to the question, "Has any standard fruit industry as few diseases and insect enemies as the pecan?"

The following resignations from the Bureau of Entomology have been reported: Gerson Garb, extension work, truck crop insects, Mineola, L. I.; Harry W. Allen, scientific assistant, and G. E. Clement, assistant in forest management, Melrose Highlands, Mass.

Mr. E. Lee Worsham has resigned his position as state entomologist of Georgia in order to devote his time entirely to the conservation of the Sea Island cotton industry. He will be engaged in cotton production on Sapelo Island, and his address will be Sapelo, McIntosh County, Ga.

According to *Science*, Dr. A. B. Cordley, Dean of Agriculture at the Oregon Agricultural College, and Director of the Station, has been elected chairman of the State Lime Committee, authorized by the legislature to build and operate a state-owned lime plant for providing cheap agricultural lime.

Moving picture films showing various phases of the gipsy-moth investigation were exhibited at the meeting of the Entomological Society of Ontario at McDonald College, and also at Ottawa, Canada, during November, and at the Pittsburgh meeting of the American Association of Economic Entomologists.

According to *Science*, Professor W. B. Herms of the University of California has been making an entomological survey of sanitary conditions in the neighborhood of the cantonments of the western department of the army, to aid in preventing the spread of those diseases, such as malaria, which are carried by insects.

The Association of Economic Biologists, at a recent meeting of the Council, decided to throw open its membership to non-British subjects. Foreign members will there-

fore have the same privileges as British ones, including the right to receive the *Annals of Applied Biology* for the annual subscription of 1 guinea (sold at 25s. to the public).

The entomological laboratory of the Tennessee Station has recently been equipped with an electric incubator, fitted with an extremely sensitive thermo-regulator. It has ample space for a large amount of material, also for a recording thermometer and hydrograph, and thermometers and a hydrograph by which the recording instruments are regulated.

Mr. Donald J. Caffrey, in charge of the Hagerstown, Md., field station of the Bureau of Entomology, visited the New England States during his vacation in December and January, and called at the entomological laboratories of the Massachusetts Agricultural College, Amherst, Mass., and the Connecticut Agricultural Experiment Station, New Haven, Conn.

Mr. Charles F. Baker, who for the past year has been assistant director of the Botanic Gardens at Singapore, and previously professor of Agronomy at the Philippine College of Agriculture, has been recalled to the Philippines to become dean of the College of Agriculture and professor of Tropical Agronomy on account of the mid-year retirement of Dean Copeland.

Mr. William M. Mann, Bureau of Entomology, has recently been commissioned to go to Cuba to continue the work which Harold Morrison was doing there in relation particularly to the white fly and other insects affecting tropical and subtropical plants, having more particular relation to pests against which it may be necessary to take quarantine or other restrictive measures to exclude from the Continental United States.

A general conference of the Hessian-fly staff was called in Washington for the first week in January, for the purpose of comparing notes, for consultation with the Chief of the Bureau and others, but especially to consider the Hessian-fly problem in connection with adaptations and modifications of agronomic practice. Experts from the U. S. Bureau of Plant Industry will be detailed to meet the Hessian-fly men in joint conference.

According to *Science* Dr. C. Gordon Hewitt, F. R. S. C., dominion entomologist and consulting zoölogist of the Department of Agriculture, Ottawa, has been awarded the gold medal of the Royal Society of Canada for the Protection of Birds, and has been elected an honorary fellow of the Society, in recognition of his services to the cause of bird protection in England and in Canada, and particularly in connection with the treaty between Canada and the United States for the protection of migratory birds.

Dr. L. P. de Bussy, formerly biologist to the Tobacco Planters' Association at Deli, Sumatra, who visited this country in 1910 in the effort to get parasites of injurious tobacco insects for importation into Sumatra, visited the Bureau of Entomology early in November on his way back from Sumatra to Amsterdam, where he is to take the position of Director of the Dutch Colonial Museum. Doctor de Bussy reports that *Trichogramma pretiosa* was successfully introduced and established in Sumatra.

Mr. M. A. Yothers, assistant entomologist of the Washington Agricultural Experiment Station, has resigned to accept a position with the Federal Bureau of Entomology at Medford, Oregon, where he will investigate fruit insects. His place has been

filled by the appointment of Mr. Anthony Spuler, B. S. in Entomology, a graduate of the Washington State College. Mr. Spuler will give his entire time to an investigation of cranberry insects in southwestern Washington, in coöperation with the Federal Bureau of Entomology.

Professor Vernon Kellogg has been associated with Herbert Hoover in the work of the Commission for Relief in Belgium since May, 1915, and in the work of the United States Food Administration since its organization. Professor Kellogg's duties in the Food Administration are advisory and editorial He also gives special attention to matters connected with the food conditions among the Allies. Professor Kellogg gave the annual address before the Entomological Society of America at Pittsburgh, Pa., December 28.

Professor H. Maxwell-Lefroy, formerly Imperial Entomologist in India, and now lecturer on applied zoölogy at the Imperial College of Science, London, visited Washington, D. C., in November on his way from England to Australia, where he is going to investigate weevil damage to stored wheat which is to be shipped from Australia to the United States. On his trip he visited the Department of Entomology at the Kansas State Agricultural College, November 26 and 27, and gave an excellent address before the Zoölogical and Entomological Seminar on "Medical Entomology in the English Armies."

The Board of Regents of the University of Minnesota at their meeting on January 18 elected Dr. W. A. Riley of Cornell, Professor of Parasitology and Chief of the Division of Economic Zoölogy. Associate Professor A. G. Ruggles was, at the same time, appointed Station Entomologist which position carries with it the office of State Entomologist. At the December meeting of the Board Professor F. L. Washburn, who has held the position of State Entomologist in Minnesota for nearly sixteen years, asked and obtained permission to be relieved of that position and its attendant police duties, and the action of the Board on the 18th was necessary to fill the vacancy thus caused.

Dr. E. F. Phillips, Bureau of Entomology, returned November 14 from an extended western trip, taken for the purpose of arranging for extension work in beekeeping. In addition to conferences with various extension directors, meetings of beekeepers were held in Utah, Idaho and California. Most beekeepers in the west are awake to the need of increasing honey production next year and are making plans to that end. The bee disease situation in California is more serious than had been realized, due to a failure of beekeepers to differentiate American foulbrood and European foulbrood. Many are attempting to treat American foulbrood by methods applicable only to European foulbrood with disastrous results.

Transfers have recently been made in the Bureau of Entomology as follows: Dr. J. A. Nelson, apiculture, to southern field crop insect investigations; R. A. Cushman, parasite work deciduous fruit insects, North East, Pa., to Wallingford, Conn.; G. F. Moznette, Federal Horticultural Board, Washington, D. C., to subtropical fruit insect investigations, Miami, Fla.; C. E. Bartholomew from Tennessee to take up extension work in beekeeping in Wyoming, Colorado, Utah and Idaho; L. C. Griffith, shade tree insects, to extension work with deciduous fruit insect control, Ithaca, N. Y.; Marion R. Smith, Washington, D. C., to Baton Rouge, La., truck crop insect investigations; Roy E. Campbell and Harold J. Ryan, truck crop insect investigations, have moved their headquarters from Pasadena to Alhambra, Cal.; K. L. Cockerham, truck crop insects, Muscatine, Iowa, to extension work at Agricultural College, Miss.; Harry M. Gillert, South Carolina to Raleigh, North Carolina.

The following recent appointments in the Bureau of Entomology have been nnounced: Robert Matheson, Cornell University, Specialist in Hymenoptera, Gipsy Moth Laboratory, Melrose Highlands, Mass.; E. F. Atwater, and G. C. Mathews, Idaho, Special Field Agents in Apiculture. Mr. Atwater will do extension work in California, Arizona and New Mexico. W. Atkins, Iowa Agricultural College, Special Field Agent, to take up extension work in apiculture in Iowa, Missouri, Kansas and Nebraska; O. G. Babcock, Colorado, to Dallas, Texas, for work in the control of insects injurious to live stock; Clyde C. Hamilton, Kansas State College, Special Field Agent for extension work in deciduous fruit insect control in Arkansas and Missouri, Columbia, Mo.; Joseph S. Stanford, Utah Agricultural College, Special Field Agent, deciduous fruit insect control in Idaho and Colorado; R. C. Pickett, Wisconsin, Special Field Agent, extension work with truck crop insects, Southern States; A. H. Sherwood, Special Field Agent, extension work in cereal and forage crop insects, Brookings, S. D.; E. G. Smyth, Porto Rico, to truck crop insect investigations, College Station, Texas; A. A. Brook, Santa Paula, Cal., collaborator truck crop insect investigations.

The following members of the Bureau of Entomology have been called to the colors:

F. L. McDonough, Quincy, Fla., to Camp Devens, Ayer, Mass.;

Geo. W. Barber, Hagerstown, Md., to Fort Leavenworth, Kan.;

Gipsy Moth Employees:

Dwight F. Barns, Flying Cadet, Signal Reserve Corps, U. S. Army, Cambridge, Mass.;

John W. Bradley, Flying Cadet, Signal Reserve Corps, U. S. Army, Cambridge, Mass.;

David Broude, Yeoman, U. S. Navy, Boston, Mass.;

Thomas M. Cannon, Private, U. S. Army, Camp Devens, Ayer, Mass.;

Henry F. Cummings, Private, U. S. Army, Camp Devens, Ayer, Mass.;

Alfred D. Darling, Pharmacist's Mate, U. S. Navy, Charlestown, Mass.;

Senekerim M. Dohanian, Flying Cadet, Signal Reserve Corps, U. S. Army, Cambridge, Mass.

Cornelius J. Driscoll, Yeoman, U. S. Navy, Washington, D. C.;

Carlisle C. Eggleston, Private, U. S. Army, Camp Devens, Ayer, Mass.;

William G. Johnson, Private, U. S. Army.

George J. McCarthy, Yeoman, U. S. Navy, Charlestown, Mass.

Willis Munro, Officers' Training Camp, Plattsburg, N. Y.;

Frederick W. Merrill, Seaman, U. S. Navy;

Rolf V. Robsham, Sergeant, U. S. Army, Camp Devens, Ayer, Mass.;

Henry J. Rosseau, Private, U. S. Army, Norwich, Conn.;

Chellis W. Stockwell, Private, Aviation Corps, San Antonio, Texas;

Orrin S. Thompson, Private, U. S. Army, Camp Devens, Ayer, Mass.

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Proceedings of the Thirtieth Annual Meeting of the American Association of Economic Entomologists

(*Continued*)

Morning Session, Wednesday, January 2, 1918, 10.00 a. m.

PRESIDENT R. A. COOLEY: There appears first on our program "Entomological Extension Work in Pennsylvania," by Mr. C. H. Hadley.

ENTOMOLOGICAL EXTENSION WORK IN PENNSYLVANIA

BY C. H. HADLER, *State College, Pa.*

(Withdrawn for publication elsewhere)

PRESIDENT R. A. COOLEY: Here is a very practical paper, giving us a picture of conditions as they are and experiences. Do you wish to ask questions? If not, I will pass to the next title, "Planning a State Extension Project in Entomology," by Mr. T. H. Parks, of Kansas, which will be read by Mr. G. A. Dean.

PLANNING A STATE EXTENSION PROJECT IN ENTOMOLOGY

By T. H. PARKS, *Kansas State Agricultural College*

Today more than ever before is felt the need of extension work in applied entomology. This is due to the necessity of an effort being made to reduce waste at a time when crop values are extremely high and food-

scarce. In the face of this demand made upon us, we must admit that the successful prosecution of extension work in applied entomology upon a project basis is still in the pioneer stage. This work has been carried out heretofore without prearranged plans and has been more or less sporadical as the needs of it were felt. Until recently the extension work in entomology has been of the nature of emergency work done by members of the Federal Department of Agriculture or State Experiment Station staff who have served in the capacity of members of a fire department subject to call upon the receipt of distress signals. These men have frequently arrived in time to find the crop already devastated, or at least so severely injured that little could be saved. As they are engaged in research work it is but natural (and the writer has been in this position) that they be more interested in getting information from the field than in giving it to the farmers. The time they could give to this work was necessarily limited and they have often been unable to outline and disseminate a plan of procedure that should prevent a recurrence of the trouble in question. Because these men have not been able to spend sufficient time in the field, farming interests have suffered heavily in the past through the state agricultural colleges and Federal Department of Agriculture being uninformed concerning insect injuries that are taking place.

The present shortage of some of our foods for export and home use has resulted in a realization on our part of the service we can render, and as a result many new men have been entrusted, during the past year, with the duty of taking our science to the field. This will probably result in extension entomology taking its place along with research and teaching work in all of the states.

The several entomologists now working under the federal and state Smith-Lever funds find one of their first problems to be the working out and successful prosecution of a definite project. The writer after spending four years in state extension work with entomology has come to the conclusion that this is not only the first but the main problem, and upon it will depend the success or failure of extension work. The difficulty encountered lies not so much in knowing how to plan the work, but to work the plan, which will have for its main object the reduction in amount of the emergency work to be done. This necessitates a thorough knowledge of state-wide crop conditions and working always just ahead of an insect outbreak if such threatens. For example, the men engaged in extension entomology in Kansas were preparing during the fall of 1917 for the grasshopper campaign of 1918, ...locating and circulating knowledge of the egg-laying places of ...western Kansas. This publicity was being done al- ... attractive exhibits of these grasshopper eggs

collected in the immediate vicinity. To the exhibit was attached a card of information of what was known about the location of the egg-laying places in that community and directions for their destruction by cultivation. The same plan is being followed with respect to control work with chinch bugs. Attractive exhibit boxes are being placed only in localities where the chinch bugs are again becoming abundant and promise to injure the crops in 1918. These show the tufts of sedge grass (*Andropogon scoparius*) which are the natural hibernating places for chinch bugs in Kansas, and the same after the back fire has burned it off and killed the bugs. Advance work with Hessian fly has given us knowledge which is of great value in carrying on extension work against this pest in 1918. For example our survey work has given us the exact localities of probable injury next year and has revealed the fact that only 50 to 60 per cent of the summer "flaxseeds" present in old wheat stubble in the infested localities gave up adult flies last fall, and that we may expect the remainder to reinforce the army of spring brood of flies.

We find that our project work must be outlined along the preventive course, and while these preventive measures are well known by us, they are either not known to, or the need for using them is not realized by, the busy farmers who often go blindly into the outbreak. One of the surprises of an entomologist entering upon extension work is to learn how little the average general farmer knows of injurious insects and their control, notwithstanding the volumes of literature that have been published, which may or may not have reached the farmer, or if so, may or may not have been read by him. Such knowledge makes it imperative to an active field worker that different methods must be used to have results of entomological investigations put into operation on the farms. The average farmer is tired of reading advice given gratuitously and wants to see you on his farm and talk with you about his conditions. This makes it necessary that the worker in extension entomology must be qualified to speak intelligently along other lines of agriculture and should have farm experience and an agricultural education. If he can bud, graft or prune correctly or can bind a sheaf of wheat by hand, the farmers' confidence is soon gained and the work of the entomologist made all the easier. Through your visit the farmer feels that he is in personal touch with the institution you represent, and the entomologist soon learns to know the methods that are practical for the farmer to use under present conditions. Getting information both to and from the counties is best accomplished through coöperation with the county farm bureau agents who understand the needs of their communities, and who through their local leaders are able to bring about a better community coöperation among farmers.

In counties having no county agent, local leaders should be found if possible and the work done through them. In Kansas, local men who through our visits have acquired a good knowledge of spraying are constantly called upon for help by others in their community.

Preliminary to the project work the extension entomologist must gather and systematize information from all sources that will be of value in his state. Much of this must come from co-workers in his college and this necessitates close coöperation with the departments of the college and especially the Department of Entomology. He should not overlook valuable information from other institutions and must serve as a sieve to separate out the published results of research work which will be of value in his state, and also see that the control measures selected thereby, before given to the farmers, are practical for them to use.

Planning the annual project in the field calls for a yearly program that will be continuous and efficient in addition to being in advance of emergency calls. The greatest part of the project work will consist in securing the application on a practical basis of the control work outlined, and this will call for perhaps 90 per cent of the time of the entomologist engaged in extension work. At the same time he will want to make some part of his control work research in nature to keep alive in him the love for new facts, and as Prof. R. A. Cooley states in his excellent paper read before the Special Meeting of this Association at Berkeley, California, in 1915,[1] to keep alive in him the true spirit of the scientist.

The extension entomologist has an excellent opportunity to see the results of control measures secured under different methods of farm or crop management, and, with his experience and training back of him, to wisely interpret the results secured by the average farmer under average farm conditions. This is illustrated by the work of a research nature done by the extension entomologist in Kansas during the season of 1916 with respect to the relation of Hessian fly damage to the presence of volunteer wheat in the seed bed at seeding time.[2] In 1917 an excellent opportunity was afforded to secure results of a research nature in demonstrating control work against grasshoppers in western Kansas. A comparison of the use of the Kansas poison bait against the hopperdozer showed that one application of poison bait killed 4.1 bushels of grasshoppers per acre, while repeated use of the hopperdozer under the same field conditions caught but 1 bushel per acre. Such work fits in well with the regular extension work in entomology and

[1] Jour. Econ. Ent., vol. 8, No. 5, October, 1915.
[2] Jour. Econ. Ent., vol. 10, No. 2, April, 1917.

furnishes to the farmers convincing proof of the value of applying the best measures of control. Besides this it instills in the worker a desire to add to information which keeps him in closer touch with his science.

In the past our project work has been divided about equally between educational and demonstrational work. In most localities the need of the former is recognized before the latter can be most advantageously staged, and serves to make the work continuous throughout the year. The accompanying outline shows the relation of extension entomology in Kansas to the organization which is behind it, the methods used to reach the farmers and the ultimate result to be obtained.

ORGANIZATION				METHOD		RESULT
State Agricultural College	Div. of Agri.	Dept. of Ent.	Extension Entomology	Education	Farm Visits Traveling exhibits Lantern slide lectures The Press	More Food Better Food Cheaper Food
U. S. Dept. of Agriculture	States Relation Service	Coöperative Extension Work		Demonstration	Spraying Poison-bait Trapping Burning Tillage	

The educational work represents the most that can be done with such insects as the Hessian fly, green bug and subterranean species with perennial habits. This branch of the work is by no means the least in importance, however, and when one can persuade a farmer by means of a personal visit to destroy volunteer wheat in his seed bed and wait until the fly-free date to sow his wheat in regions where Hessian fly is abundant, he is performing a real service and the farm visit is the surest way to bring this about. It is very important to plan these visits to be timely in order to secure the best results. The best time to make these farm visits, or auto tours, to observe the effect of volunteer wheat in the seed bed and the good of observing the fly-free date in sowing, is during March and April before the spring brood of Hessian flies has complicated the results. A visit at this time to wheat fields in one community in company with a group of farmers does more to convert them to using better methods against the Hessian fly than a front page story on the agricultural weekly. Farmers' institutes afford a good opportunity by which to present the educational work. In Kansas we have been using lantern slide lectures at these institutes and movable schools to acquaint the farmers with insect habits and the methods of control. We hope to replace these with moving pictures of insect control work, and the writer believes that moving pictures will in the

future serve as one of our best methods of educational work with entomology extension. Farmers' institutes and movable schools not only make the work continuous throughout the year, but also serve to prepare a community for demonstration work to follow. Many of our orchard demonstrations have been located as a result of these lectures and through which the communities were made ready for the spraying demonstrations.

Traveling exhibits have just been installed in Kansas and are expected to speak for themselves and give information at the right time for control. They are made up by the extension worker from material collected in the community and exhibited at public places only in communities where need for control is known. They are on display in one locality as long as the control method suggested can be applied during that year. The next year fresh exhibit material will be placed in that or other localities as the need for them is apparent. Care must be used in determining the places they are exhibited. In our eagerness to serve we are often forgetful of the fact that medicine is intended only for sick people and scatter our information in localities where it is not needed. The writer has often viewed the patriotic advertisement of an enterprising fertilizer company which copied the drawings and suggestions of the U. S. Bureau of Entomology in a publication on the Hessian fly and incorporating this with their fertilizer advertisement, had posters put up under glass in depots in western Kansas where the Hessian fly has never been known and where commercial fertilizers are not needed.

We find that exhibit material collected locally and showing the location of insects during the time of year they can be most easily destroyed, such as grasshopper eggs and chinch bugs, not only attract more attention than posters, but the suggestions accompanying are more apt to be used on the farms and thus an outbreak of insects disposed of in its incipiency.

Newspaper articles are of great value when timely and reach the largest number of people with least effort. Unfortunately we have no way of knowing how much good they do.

The demonstrational work gets the visible results and stands as an object lesson to the community. Work of demonstrational character must have the right of way and if possible be scheduled well in advance. Plans can be made for the control of fruit insects in advance, and one knows pretty clearly how much time the work will take. In Kansas spraying demonstrations for the control of fruit insects have been going on for seven years and are distributed throughout the eastern part of the state, orchards being accepted for this purpose under written contract with the owners.

These orchard spraying demonstrations admit of prearranged plans which are always carried out as scheduled. This is possible because one knows in advance what orchard insects to expect and when the spray must be applied. Consequently, the county agents and our co-operators on the farms know approximately when we shall be with them for supervising the spraying.

That part of the project covering the work with staple crop insects is subject to a moment's change. We are unable to anticipate in advance outbreaks of such staple crop insects as army worms, sod webworms, or army cutworms, and can combat them only as they appear. However, that part of the project covering staple crop insects calls for definite work for each month from March to December, and is prepared with a view to working in advance of outbreaks as much as possible. For example, the educational work in the field to reduce the injury from Hessian fly that will result in 1918, was started during March and April, 1917. At that time farm visits were made in sections where the Hessian fly is abundant and the farmers' attention called to the absence of Hessian fly in fields where good practices against the fly were used in seeding the wheat crop the previous autumn; likewise the abundance of overwintering fly in volunteer or early sown wheat. These visits bear fruit the following summer when these farmers prepare their ground for wheat. Owing to advance knowledge about the egg-laying places of grasshoppers in western Kansas, poisoning next year will commence in May, which is about two months before complaints come in from the farmers and before the insects have scattered.

Wherever advance information can be obtained it will help the extension entomologist to plan the yearly project and enable him to outline a program which, when followed out, will accomplish the most good with the least expenditure of funds. This should be the hub about which his project activities are centered. With this information at hand it is possible for the extension entomologist to install system into his work, and he is able to be on the ground in advance of an insect outbreak. Working his plan then consists in administering a "serum treatment" both to the farmer and his farm. It is too much to expect that the result will be to "immunize" against insect outbreaks, but if the entomologist is successful in carrying out his plans it will do much to reduce their frequency and violence.

President R. A. Cooley: Do you wish to ask Mr. Dean any questions about this paper?

Mr. Herbert Osborn: I would like to just make one remark—

that is, to emphasize that research work is possible for extension workers to do, but extension should not be drawn away by research. It does seem to me that if they have the right spirit, they can do a good deal of research work and it would be a very great advantage to them as well as to the station with which they may coöperate.

President R. A. Cooley: I will now call for Mr. Hunter's paper, "Municipal Control of the Spring Canker Worm."

MUNICIPAL CONTROL OF THE SPRING CANKER WORM

By S. J. Hunter, *University of Kansas, Lawrence*

During the last two years the spring canker worm has been unusually abundant and destructive in cities of the eastern half of Kansas, as well as in the native woods. This has afforded an excellent opportunity for the study of the biological problems connected with its life.

Since this phase of the work has recently been published in Bulletin No. 11,[1] of the Department, this paper will be confined entirely to the methods used in dealing with this insect in the city of Lawrence during the spring of 1916 and 1917.

When, in January of 1916, our scout work revealed the probable forthcoming outbreak of the canker worm, announcement was duly made and in accordance with instructions given through the press, many property owners placed bands on the elm trees and covered them with the "Tanglefoot" or other sticky substance one or more times. A few kept the bands properly renewed with the "Tanglefoot" throughout the spring, in accordance with the instructions given. The results were unsatisfactory because there were enough worms bred on the unprotected and partially protected trees to defoliate them, and also to travel from adjoining trees through interlocking branches to trees which had been properly protected.

In a letter of December 21, 1917, a prominent citizen of Topeka, Kansas, gives this point as follows:

"My property here in Topeka is protected on two sides by fine elm trees. I have been battling to save the lives of these trees for the past three years, against the ravages of the canker worm, both by banding and spraying my trees. I have perhaps helped them a lot but still they have suffered severely and I am afraid that I am going to lose some of them. The loss of this shade to my place which faces the western summer sun, would make a Kansas summer almost unbearable and cut the value of the property in two. I am going to do everything I can to save them, but if your neighbor doesn't band his trees and look after the banding most vigilantly, it apparently does no good."

[1] W. H. Wellhouse, Bul. No. 11, Department of Entomology, University of Kansas, October, 1917. Pp. 281–315; plates I–III.

In the spring of 1917 the canker worm began to ascend the 3d of January. On the 23d of January the city commissioners ordered the elm trees banded, and the cost of the work, when done by the city, taxed to the properties. The city banded 6,000 trees and the property owners banded 5,000 trees. Due to the lateness in beginning the work, some of the under branches were defoliated by the worms whose wingless parents had ascended the trees before the bands had been put on. Not a single tree, however, that the city undertook to protect was stripped of its leaves, nor has a single one of these trees died; while in adjoining property under private protection, trees were defoliated and died and are now being used as a substitute for coal in furnaces and fireplaces.

The city renewed the "Tanglefoot" from 10 to 13 times on the trees under its protection. The cost of labor and materials was covered on a scheduled price of twenty-five, fifty, and seventy-five cents per tree for the season, depending on the size of the tree. These renewals required, likewise, the burning off of the insects on the bands, with a blow torch, before the fresh application of "Tanglefoot" could be put on. The bands were kept fresh with "Tanglefoot" until May 1. Unless the work is done thoroughly and persistently, it is possible for enough insects to cross the bands at such times as they are neglected, to make the work only partially effective.

In dealing with the canker worm in cities the use of arsenical spray is not safe, practical, or economical. The spray stains the paint on the buildings and property owners object to its use over houses where roofs drain into cisterns. The expense is many times that of banding. Chief of all, however, is the fact that much of the damage is done by the canker worm at the initial opening of the bud before it is large enough to catch the spray.

The plan of the administration under which banding was required was worked out by the city attorney. Under this plan the state entomologist was appointed city forester and instructed to have the work performed and the cost charged to the property owners, in accordance with state laws governing such work.

A mattress factory made the tar paper bands with a mixture of cotton and jute glued to the under side. These bands were handled in rolls of twenty-five feet. Many experiments with adhesive substances were made for the purpose of covering these bands. Some of these were too thin, and others were too thick, and quickly coated over. The ingredients principally used in these experimental bands were mixtures of road oil No. 7, lime, castor oil, resin, vaseline, burlap soaked in kerosene, etc. The female canker worm gave us many surprises by its strength in wading through adhesive substances. Taken altogether,

we found nothing so uniformly satisfactory as the substance known as "Tanglefoot."

The moth and the worms which hatched below the bands were captured on their way up. Those which ascended prior to the banding were captured on their way down. Just how fully we have succeeded in destroying this 1917 brood by the work of the past spring it is not possible to predict this early in 1918.

The nature of the work as conducted can probably best be illustrated from the lantern slides, which were then shown. See illustration on plates I, II and III in Bulletin, Department of Entomology, University of Kansas, No. 11, October 1917.

President R. A. Cooley: Do you wish to discuss this paper?

Mr. W. H. Goodwin: I have been making some studies of the canker worm for probably sixteen years, mostly in Ohio and some of the things are interesting there. One of these is the spread of the fall canker worm. It occurs during the first three days after the canker worms hatch. They spin threads and sail away with the prevailing winds. They can spread considerable distances, I judge, at least a half mile. In some large, old orchards, bands that were put on became fifteen to twenty inches wide. I estimated that twenty trees about thirty feet high had in the neighborhood of thirty thousand females in each band. In the orchard work, spraying with arsenates was especially effective if done during the first and second instars. If they got any larger, it was practically impossible to kill them.

Secretary A. F. Burgess: I am interested in this paper from a different angle. I wonder if any of us have studied the behavior of female canker worms in connection with tree banding substances. On the gipsy-moth work, we find that the tree-banding material that we used last year was satisfactory; that is, a large percentage of the caterpillars did not make any very serious attempt to cross the bands. Of course, with the canker worm the problem is different, because the females attract the males, and a considerable number of these are bound to be caught in the sticky substance, which, of course, automatically would furnish a bridge for the females to go over. I think there is a chance for some excellent work to be done in connection with the behavior of the females where bands of different kinds are used. It may be that a repellent could be used in connection with the band which would keep the females from crossing. We are doing some work along that line in connection with gipsy-moth caterpillars.

In the great apple growing section in Nova Scotia, they are having very serious trouble with canker worms. When we were making up

our tree-banding material this fall—we made up about nine tons for use next spring—a representative from the entomologist's office came down and we made up a half ton for experimental work there this fall. I am not convinced that this material is going to work out as satisfactorily on the canker worm as it does on the gipsy moth, but as a result of these experiments this will be determined. In connection with using Tanglefoot bands, we have found it very useful to comb the bands after they become hardened a little, either from excessive heat or from dew or foreign matter. We have a little wooden comb that is about three inches wide and the men comb these bands, which freshens them up and takes out a certain amount of foreign matter. By following this method, it is not necessary to re-surface the bands.

Mr. S. J. Hunter: We first tried the regular stone mason's trimming comb—a comb with fifteen teeth, but in the very beginning met difficulty with the males. We found that the torch did the work better.

Regarding the repellents, we not only wanted to find something that would keep the moth from crossing, but we wanted to find something that would kill her when she crossed. We wanted to get something in the dope that would act as an insecticide on her body. We didn't succeed. For instance, they would wade across four and five inch bands of vaseline and then lay their eggs.

Mr. W. H. Goodwin: I would think that the problem would be much more difficult in the eastern sections where we have both species of canker worms. Sometimes they go up as early as the latter part of October and some of them as late as the twelfth of April, which means that you would have to keep your bands on for a period of from four to five months.

Mr. G. A. Dean: Mr. Chairman, I had the pleasure of going over the city of Lawrence with Professor Hunter, after his work there and the part that impressed me was what can really be done when someone takes this work out of the hands of individuals and the work is done as it should be. That city was practically absolutely protected with the exception of these few places that furnish the check. It was certainly a fine piece of demonstration work.

As for repellents, I don't believe you will find that repellents will stop the female canker worm. The moth apparently will cross anything. The fall canker worm is not a serious pest with us in Kansas, and the canker worms in the orchards are easily controlled by our orchard spraying method, because the various sprays applied that control the codling moth also control the canker worm.

President R. A. Cooley: If there is no further discussion, we will pass to "Notes on Fumigation of Orchids," by Mr. E. R. Sasscer and Mr. H. F. Dietz.

NOTES ON FUMIGATION OF ORCHIDS

By E. R. Sasscer and H. F. Dietz, *Washington, D. C.*

(Withdrawn for publication elsewhere)

President R. A. Cooley: Do you wish to discuss this paper or ask questions?

Mr. T. J. Headlee: Mr. Chairman, I might inquire whether the cattelyæ fly in the orchid leaf is killed by this process.

Mr. E. R. Sasscer: We haven't checked up on that. I have about reached the conclusion that we cannot kill any of these insects with plant fumigation. I would not recommend this fumigation to control any insect imbedded in the plant.

President R. A. Cooley: I will call for Mr. McConnell's paper, "*Mira saltator* Lindm, as a Parasite of the Hessian Fly."

EUPELMINUS SALTATOR LINDM. AS A PARASITE OF THE HESSIAN FLY

By W. R. McConnell, *Cereal and Forage Insect Investigations, U. S. Department of Agriculture*

During the course of our studies of the parasites of the Hessian fly we have reared another parasite as yet unrecorded in American literature. As is commonly the case with a parasite of an introduced insect, its determination has been a troublesome matter because of the inaccessibility of the type and the lack of properly identified representatives.

Specimens were submitted to Mr. A. B. Gahan, of the National Museum, who regarded them as identical with a parasite described from Russia by Lindemann (1) under the name *Euryscapus saltator*. He placed it in the genus *Mira*, with which *Euryscapus* has commonly been regarded as synonymous. Since the title of this paper was submitted, Mr. Gahan has studied this species further and has written regarding it as follows: "I have been fortunate enough to find in the collection here part of a specimen labelled *Euryscapus saltator* in what I believe to be Lindemann's own handwriting. It was in the box of *Pleurotropis epigonus* and other European parasites of the Hessian fly. We know that specimens of some of Lindemann's species were sent to Riley and there seems to be no reason to doubt that this broken one is authentic, whether the label is Lindemann's or not. Only the

thorax remains but this is enough to prove that the specimen was a wingless Eupelmine similar to the species in this country and not a *Mira*. What is left of the specimen agrees perfectly with your specimens, so far as I can see, so there seems to be no reason to think that the determination of our species is not correct. The name *Mira* should not be used for the genus, however, since *Mira* as now understood is not a Eupelmine." Still later Mr. Gahan wrote regarding the generic position of this parasite: "*Eupelminus* is the generic name applied to a lot of Eupelmines which are wingless or with rudimentary wings. I really do not think that this is generic but for the present it will probably be better to use the name since it does identify the species to some extent. The name to be used then will be (*Mira*) *Eupelminus saltator* Lindm."

The opinion has also been expressed by Mr. Gahan that this is the same parasite which Mr. W. J. Phillips of the Bureau of Entomology has reared from the galls of various species of *Harmolita* (*Isosoma*).

While our knowledge of this species as a parasite of the Hessian fly is by no means complete, yet it seems worth while to place upon record the fact of its occurrence in this country together with the facts we have accumulated regarding its life-history. The biological data are based on experiments conducted in the laboratory at Hagerstown, Md., chiefly during the season of 1916. The writer has been aided in the collection of material upon which the field records are based by Messrs. P. R. Myers and P. H. Hertzog. Mr. Myers has also given very valuable assistance in rearing the field puparia and has carried out some experiments on the parthenogenesis of this species.

Distribution

Lindemann's specimens were reared from puparia which he collected at Moscow and in various governments of central Russia. He states that he has never found the species abundant, but it is probably widespread in Europe, and was undoubtedly introduced into this country at an early date in infested straw. There are apparently no other records in literature.

We have reared it from the following nine localities in Pennsylvania: Carlisle, Andersonburg, State College, Danville, Montoursville, Linden, Butler, Greenville and Linesville; from Hagerstown and Braddock Heights in Maryland; and from Strasburg and Woodstock in Virginia. Mr. Phillips has reared it from *Harmolita* material from Michigan, Indiana, Ohio, New York, Pennsylvania and Virginia, and probably from other states.

The species has not been an abundant parasite of the Hessian fly during our investigations. The greatest number were found in a field

at Greenville, Pa., in 1915, where 6.67 per cent of the puparia were parasitized by it.

Hosts

Eupelminus saltator is a primary parasite of the Hessian fly, attacking externally both larval and pupal hosts inside the puparium. We have repeatedly demonstrated the primary nature of its attack by rearing it experimentally from puparia known to be free from other parasites. It may, however, become a secondary parasite of the fly, since a puparium from which an individual emerged was opened and found to be filled with cocoons of *Polygnotus*, from one of which it had issued.

Lindemann mentions that he had reared this parasite from *Harmolita hordei*. Mr. Phillips has kindly furnished a list of eight species of *Harmolita* from the galls of which he has reared it. These are *H. tritici*, *H. vaginicola*, *H. maculata*, *H. albomaculata*, and four new species of the same genus. He is certain that they have come from the galls of *Harmolita*, but is not sure whether they were primary or secondary there. There is little doubt, however, that this species is ordinarily primary, but when other parasites are abundant it can just as easily become secondary.

The Adult

This parasite belongs to the family Encyrtidæ, subfamily Eupelminæ, and can easily be distinguished from its nearest relative among Hessian fly parasites, *Eupelmus allynii* French, by its indistinct parapsidal grooves and poorly developed wings. No males are known, but the females are further distinguishable from those of *E. allynii* by their well exerted ovipositor. The wings are small and do not function. The tip of the anterior wings is bent upward at a right angle so that the apical portion is held in a vertical position; the posterior wings are shorter, very narrow, and are turned upward at the tip. While the adults are unable to fly, they are remarkably good leapers.

They normally emerge through a rounded hole near the posterior end of the puparium. Before beginning to oviposit they rest and feed for a period of two to five days, this preoviposition period probably averaging about three days. In cages they will feed on sugar solution, and they have been observed also to puncture the host with the ovipositor and feed at the wound. In one case the same puparium was punctured several times and feeding observed to take place after each puncture. This puparium, after being kept in a cage for some weeks, was found to contain a dead fly pupa, and there is little doubt that the host was killed by the feeding punctures.

When ready to oviposit the female walks back and forth over the

infested stems or stubbles with antennæ bent forward and downward and kept in constant vibration. When a suitable location is found, the abdomen is contracted longitudinally, the tip bent downward and the ovipositor pushed into the stem. If no puparium is present, the ovipositor is promptly withdrawn, but when a host is found oviposition may require several minutes. They oviposit only during daylight, and preferably during bright weather.

A female may lay as many as five eggs in a day, and probably more. She may rest from oviposition for a day or two at a time. Females have lived in cages and oviposited over a period of 3 to 24 days, and other females which never oviposited have lived as long. The maximum number of stages reared from a single female was 39, but it is necessary to make allowance for considerable mortality, and it seems probable that a female may lay at least a hundred eggs. On the other hand, some females seem to be unable to oviposit. These are small individuals which for one reason or another have had an insufficient amount of food during the larval period.

Unfertilized females are thelyotokous. Mr. P. R. Myers has reared this species through five successive parthenogenetic generations and the writer, starting with a different female, has carried them through six such generations without the appearance of a male in any case. The sixth of these generations appeared during the past summer, but the individuals were small in size and never oviposited. This was undoubtedly due to a scarcity of good host material upon which they could develop, and not to the lack of fertilization.

The Egg

The eggs (Fig. 8, 1) are deposited on the outside of the host larva or pupa inside the puparium, and cling lightly to the host. They are white in color. The chorion is thin and elastic, with a smooth and shining surface. They are ellipsoidal in form with a large pedicel at the cephalic pole and a slender flagellum at the caudal pole. They measure 0.374 mm. in length by 0.133 mm. in greatest width, taking the average of five eggs. The pedicel is about half as long as the egg and is usually folded back along the side of the egg, its tip being recurved forward, but it may be bent and twisted in various ways. The flagellum at the posterior pole is about half as long as the pedicel and usually lies against the posterior surface of the egg. It is very slender and structureless, and, as Marchal (2) has suggested for *Platygaster* and related genera, it probably results from the degeneration of the follicular cells surrounding the posterior pole of the ovarian egg.

During April and May in the laboratory the eggs hatched in about three days. In the process of hatching the larva breaks through the chorion near the base of the pedicel and slowly crawls out.

The Larva

The larva when first hatched is about 0.4 mm. long, slightly depressed, widest in the metathoracic region, and tapering to a rather acute abdomen. The head is com-

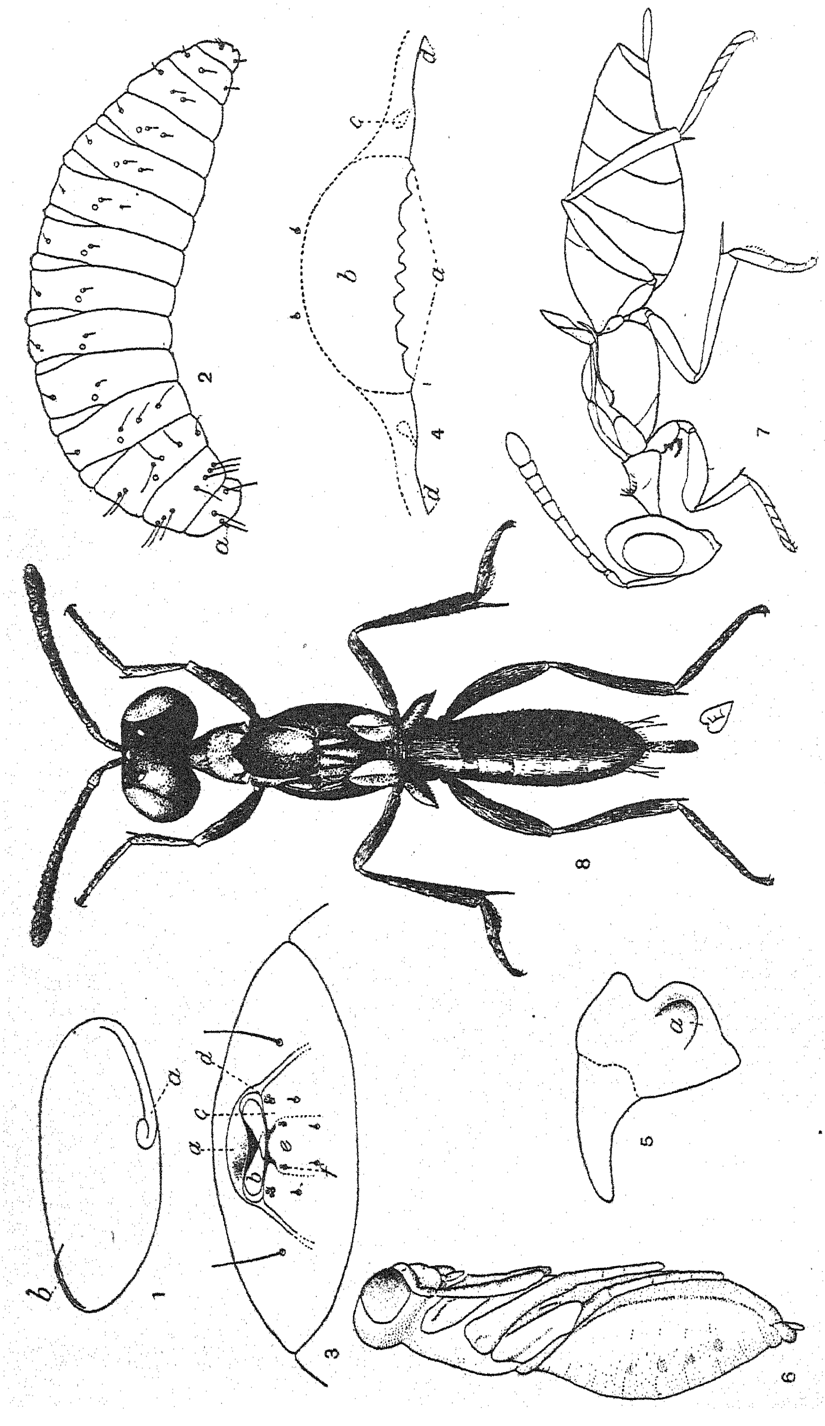

Fig. 8.—For caption, see facing page.

paratively large, convex anteriorly, and slightly narrower than the prothorax. The body color is grayish white, with very pale brownish head and large brownish black mandibles, which are simple curved hooks. The body and head are provided with long hairs, as is the mature larva.

The mature larvæ (Fig. 8, 2) vary greatly in size, but average about 2.75 mm. in length. They are white, with dark brown mandibles. The body is of the usual chalcidoid form, somewhat spindleshaped and concave ventrally. Head short, convex, without tubercles, slightly higher than wide, and partially immersed in the prothorax. Antennæ not jointed, cylindrical, with bluntly rounded apex. Mandibles simple, curved, heavily chitinized hooks, with dorsal and ventral articular processes (Fig. 8, 5). The labrum and the region dorsal to it form a concavity (Fig. 8, 3), the central part of the labrum being heavily chitinized (Fig. 8, 4, *b*) and bearing teeth on its ventral edge. These teeth are triangular and a little over 0.003 mm. long. They are irregular in number and arrangement, varying in number from 6 to 9 and are separated by interspaces usually at least as wide as the height of the teeth. The lateral regions of the labrum are very thinly chitinized and the mandibular processes (Fig. 8, 4, *c*) are difficult to see. The maxillæ (Fig. 8, 3) are thin and transparent and separated from the labium by a shallow notch. Each maxilla bears a cluster of three very small tubercles which probably represent the palpus. The labium is also thin and transparent and bears two pairs of very small tubercles probably representing the labial palpi. The head bears 8 long hairs; one pair submedian on the dorsal posterior part of the epicranium; one pair between and slightly below the level of the antennæ; another pair in the same plane posterior to the above; and a fourth pair ventral to the last and a short distance posterior to the mandibles. In addition there is a pair of small hairs dorsal to the labrum.

The body consists of the usual 13 segments. Spiracles are present on the last two thoracic and first seven abdominal segments. Prothorax with 7 pairs of long hairs; 3 dorsal, 1 lateral and 3 ventral. Mesothorax with 6 pairs of hairs: 2 dorsal, 1 lateral, and 3 ventral. Metathorax with 4 pairs of hairs: 1 dorsal, 1 lateral and 2 ventral. The thoracic hairs are all long except the dorsal metathoracic pair. Abdominal segments 1–9 each bear a pair of subdorsal hairs and a pair of lateral hairs. Segments 5–9 have in addition a pair of ventral hairs. Segment 10 bears 4 short bristles on the dorsal lobe and 2 on the ventral lobe. The abdominal hairs are all much shorter than those on the head and thorax, but increase in length on segments 8 and 9.

The young larvæ soon attach themselves to the host by means of the mandibles and use the tip of the abdomen to help anchor the body. They crawl with a leech-like movement, and when disturbed frequently retain their hold on the host by means of the mandibles and sway the body about the head as a fixed point.

EXPLANATION OF FIGURE 8)

Fig. 8, 1. Egg x 230, *a* Pedicel, *b*, Flagellum. 2. Mature larva, lateral view x 50, *a* Antenna. 3. Head of larva, ventral view x 216, *a*, Labrum, *b* Mandible, *c* Maxilla, *d* Maxillary palpus, *e* Labium, *f* Labial palpus. 4. Labrum, cephalic view x 960, *a* Toothed region, *b* Heavily chitinized concave area, *c* Mandibular process, *d* Angle of mouth. 5. Mandible, ventral view x 750, *a* Ventral articular process. 6. Pupa, lateral view x 40. 7. Adult female, dorsal view x 40. 8. Adult female, lateral view x 40. All figures have been reduced one-half. Drawings 6–8 have been made by Miss E. H. Hart.

Within two or three days after the larvæ attach themselves to the outside of the host, the latter dies, soon becomes flabby, and turns to an ashy gray color. The larva slowly absorbs the contents of the host skin, increases in size and finally nothing remains of the host but the empty skin, which is usually pushed into one end of the puparium. When the host is dead or in a partly desiccated condition at the beginning of the attack, the larva may live for a time but ultimately dies.

The larval stage requires a period of 8 to 12 days for complete development. Near the end of this stage the alimentary canal becomes completely developed and the waste material accumulated in the ventriculus is voided into one end of the puparium. In less than a day after defecation occurs the larva transforms to the pupal stage.

The Pupa

The pupa (Fig. 8, 6) is at first white, turning rather rapidly to pale reddish brown and light brown. It varies in length from 1.41 mm. to 2.50 mm., with an average for 15 individuals of 2.08 mm. The head is slightly wider than the thorax, its greatest width averaging 0.58 mm. The pupa is slightly depressed and slightly concave ventrally. The ovipositor sheath is turned upward, but does not extend dorsad of the abdomen.

The pupa stage requires 8–12 days in May and June, with an average of about 10 days. In midsummer this stage is undoubtedly shorter.

Number of Generations

In the laboratory the average time required for development from egg to adult varied greatly with the season. In May it averaged 25 days; in June, 24 days; in July, 18 days and in July–August 23 days. The shortest period of development recorded was 15 days during July. Most larvæ which develop from eggs laid during the latter part of August and September remained over winter in the condition of mature larvæ, emerging as adults the following May. The average period required for development in the overwintering generation, based on 19 individuals, was 265 days.

Five generations were reared in the laboratory in 1916 between April and September. A sixth generation overwintered, and emerged the following May. Thus it was possible to rear six generations in about a year. Under field conditions at Hagerstown, Md., hibernating larvæ were found in puparia late in the spring. Adults probably do not emerge outdoors before the middle of June at about the time puparia of the spring brood of the Hessian fly are appearing. In a season like 1916 there is time for four generations to develop during the summer, which with the hibernating generation, makes five gen-

erations a year. During a comparatively cool summer, like that of 1917, there were probably not more than three generations produced.

While up to the present time *Eupelminus saltator* has been of inconsiderable importance in the natural control of the Hessian fly, it is also true that during the time we have had it under observation there has been no extensive outbreak of either the Hessian fly or *Harmolita*. It seems probable that when either of these hosts becomes abundant, the numbers of the parasite will increase and aid in reducing the numbers of this host. In case the alternate host becomes abundant the following season, the parasites will then be ready to turn their attention to it in increased numbers and with considerable effect. It will be necessary to keep this parasite under observation for a series of years before its real value can be correctly estimated.

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President R. A. Cooley: The next paper is "Grasshopper Observations, Experiments and Demonstrations in Arizona, During 1917," by Mr. A. W. Morrill.

EXPERIMENTS WITH GRASSHOPPER BAITS WITH INCIDENTAL OBSERVATIONS ON THE HABITS AND DESTRUCTIVENESS OF THE DIFFERENTIAL GRASSHOPPER (MELANOPLUS DIFFERENTIALIS)

By A. W. Morrill, *Phoenix, Arizona*

In connection with demonstration work against grasshoppers in Arizona during the past season problems were presented which led to the series of observations and tests which form the basis of this paper. It was at first believed that one or two days' work would give the desired information but the results failed to meet expectations in this respect. Although the conclusions which may be drawn from these experiments are not as definite as desired, this paper is presented in the hope that it may be of some use during the coming season in suggesting profitable lines of work to others interested in grasshopper control as well as of some direct value as a contribution to our literature on this subject. The experimental work here reported was

planned and supervised by the writer, the records being made by two assistants, Mr. George Acuff and Mr. F. G. Fisk.

Poisoned Bait Experiments

The testing of baits was done in alfalfa fields where the insects were fairly evenly distributed and at a time when practically all were in the adult stage. Six series of tests were made, beginning July 24 and ending August 6. The differential grasshopper (*Melanoplus differentialis*) predominated to the extent of at least 95 per cent. Altogether 3,276 records were made including a total of 10,103 specimens.

The baits to be tested were prepared at the laboratory, divided into two parts in each case for the first 97 experiments, and one lot for each experiment of the series was used by Mr. Acuff and the other lot by Mr. Fisk. To prevent drying out the materials were taken to the fields in paraffined paper sacks. In order to have an equal amount of surface of the various mixtures exposed to the air and for convenience in handling, the contents of the sacks were emptied into shallow tin pans, eight inches in diameter, marked with the same numbers as the sacks for identification, and distributed in rows with intervals of ten feet in localities where the grasshoppers were numerous and quite uniformly distributed. The two observers worked in different fields conducting the same tests simultaneously and their records were afterward combined by the writer.

Observations were made at intervals of fifteen minutes and a record was made in each case of the number of the insects found feeding or resting on the bait or within six inches of the pan in any direction. In passing along the row of pans for the purpose of making the observations and of adding water from time to time in order to keep the baits in a moist condition, the hoppers were driven away from the baits to a greater or less extent. This was counteracted by the observer in each case, after completing the series of records, walking along the line of pans once on each side and about fifteen or twenty feet away. In some cases the entire row of pans was moved a few feet to one side or the other in accordance with the observers' judgment as to the best means of securing the most uniform conditions throughout the period when the baits were exposed.

It was found that the activity of the hoppers made it unusually difficult to conduct field experiments on a small scale. From the first series of observations it was evident that a liberal allowance must be made for errors and variations and that no conclusions should be drawn except through the grouping of records or from observations repeated several times. As a general check, every other pan in one series (D) was used for the same bait combination, consisting of bran, canteloupe and water.

TABLE I—TESTS OF GRASSHOPPER BAITS

	Exper. No.	Bran	Sawdust	Molasses	Lemon	Orange	Tomato	Cantelope	Peach	Watermelon	Paris green	Water	Grasshoppers Recorded
Series A—July 24	1	..	..	X	..	..	..	..	..	..	..	..	33
	2	..	..	..	X	..	..	..	..	..	..	..	47
	3	..	..	..	..	X	..	..	..	..	..	..	96
	4	..	..	..	..	..	X	..	..	..	..	..	109
	5	..	..	..	..	..	..	X	..	..	..	..	184
	6	X	..	..	..	..	..	..	..	..	..	..	37
	7	X	..	..	..	..	..	..	..	..	..	X	28
	8	X	..	X	..	..	..	..	..	..	..	..	55
	9	X	..	X	..	..	..	..	..	..	..	X	124
	10	X	..	..	X	..	..	..	..	..	..	..	44
	11	X	..	..	..	..	..	..	..	..	..	..	44
	12	X	..	X	½X	..	..	..	..	..	..	X	65
	13	X	..	X	X	..	..	..	..	..	..	X	88
	14	X	..	X	1½X	..	..	..	..	..	..	X	56
	15	X	..	X	X	..	..	..	..	..	X	X	58
	16	X	..	..	X	..	..	..	..	..	X	X	88
	17	X	..	2X	X	..	..	..	..	..	X	X	52
	18	..	X	X	X	..	..	..	..	..	X	X	58
Series B—July 27	19	..	..	X	X	..	..	..	..	..	..	X	48
	20	X	..	X	X	..	..	..	..	..	..	X	166
	21	X	..	..	X	..	..	..	..	..	..	X	158
	22	..	..	X	..	X	..	..	..	..	..	X	52
	23	X	..	X	..	X	..	..	..	..	..	X	160
	24	X	..	..	..	X	..	..	..	..	..	X	215
	25	..	..	X	..	..	X	..	..	..	..	X	91
	26	X	..	X	..	..	X	..	..	..	..	X	181
	27	X	..	..	..	..	X	..	..	..	..	X	213
	28	..	..	X	..	..	..	X	..	..	..	X	58
	29	X	..	X	..	..	..	X	..	..	..	X	214
	30	X	..	..	..	..	..	X	..	..	..	X	163
	31	..	..	X	..	..	..	..	X	..	..	X	58
	32	X	..	X	..	..	..	..	X	..	..	X	152
	33	X	..	..	..	..	..	..	X	..	..	X	171
Series C—July 30	34	X	..	X	..	..	X	..	..	..	..	X	121
	35	X	..	..	..	..	X	..	..	..	..	X	110
	36	X	..	..	..	..	2X	..	..	..	..	X	88
	37	X	..	X	..	..	..	..	..	..	..	X	102
	38	½X	½X	X	..	..	X	..	..	..	..	X	114
	39	..	X	X	..	..	X	..	..	..	..	X	68
	40	..	X	..	..	..	X	..	..	..	..	X	27
	41	..	X	..	..	..	2X	..	..	..	..	X	17
	42	..	X	X	..	..	..	..	..	..	..	X	53
	43	X	..	X	..	..	..	2X	..	..	..	X	135
	44	X	..	..	..	..	..	2X	..	..	..	X	152
	45	X	..	X	..	2X	..	..	..	..	..	X	99
	46	X	..	..	..	2X	..	..	..	..	..	X	82
	47	½X	½X	X	..	X	..	..	..	..	..	X	78
	48	½X	½X	..	..	X	..	..	..	..	..	X	82
	49	..	X	X	..	X	..	..	..	..	..	X	59
	50	..	X	X	..	X	..	..	..	..	..	X	53
	51	..	X	..	..	2X	..	..	..	..	..	X	58
	52	X	..	2X	..	..	..	..	..	..	..	X	76
	53	..	X	2X	..	..	..	..	..	..	..	X	60
	54	X	(1 oz. sour milk)			..	..	..	..	..	..	½X	72
	55	X	(2 oz. sour milk)			..	..	..	..	..	..	½X	85
Series D—July 31	56	X	..	..	..	..	..	X	..	..	..	X	100
	57	X	..	..	..	..	..	2X	..	..	..	X	91
	58	X	..	..	..	..	..	X	..	..	..	X	82
	59	X	..	X	..	..	..	2X	..	..	..	X	111
	60	X	..	..	..	..	..	X	..	..	..	X	50
	61	½X	½X	X	..	..	X	..	..	..	..	X	83
	62	X	..	..	..	..	..	X	..	..	..	X	79
	63	½X	½X	..	..	..	X	..	..	..	..	X	86
	64	X	..	..	..	..	..	X	..	..	..	X	71

TABLE I—TESTS OF GRASSHOPPER BAITS—*Concluded*

	Exper. No.	Bran	Sawdust	Molasses	Lemon	Orange	Tomato	Canteloupe	Peach	Watermelon	Paris green	Water	Grasshopper Recorded.
Series D—July 31	65	½X	½X	X	..	..	..	X	..	..	..	X	86
	66	X	..	..	..	..	..	X	..	..	..	X	75
	67	½X	½X	..	..	..	..	X	..	..	..	X	105
	68	X	..	..	..	..	..	X	..	..	..	X	78
	69	X	..	X	..	..	..	..	..	X	..	X	68
	70	X	..	..	..	..	..	X	..	..	..	X	58
	71	X	..	..	..	..	..	..	..	X	..	X	45
	72	X	..	..	..	..	..	X	..	..	..	X	75
	73	X	..	X	..	..	..	..	..	2X	..	X	77
	74	X	..	..	..	..	..	X	..	..	..	X	53
	75	X	..	..	..	..	..	..	..	2X	..	X	57
	76	½X	½X	..	..	..	..	..	..	2X	..	X	90
Series E—August 4	77	X	..	..	..	..	..	X	..	..	..	X	37
	78	X	..	..	..	..	..	7X	..	..	..	X	54
	79	½X	½X	..	..	..	..	7X	..	..	..	X	78
	80	½X	½X	X	..	..	..	7X	..	..	..	X	66
	81	X	..	..	..	..	2X	..	..	..	..	X	35
	82	½X	½X	..	..	..	2X	..	..	..	..	X	62
	83	½X	½X	X	..	..	..	..	..	..	..	X	54
	84	X	..	..	..	X	..	..	..	..	..	X	59
	85	½X	½X	..	..	X	..	..	..	..	..	X	41
	86	½X	½X	X	..	X	..	..	..	..	..	X	57
	87	X	..	..	..	..	..	X	..	..	..	X	34
	88	X	..	..	..	..	..	..	..	10X	..	X	48
	89	½X	½X	..	..	..	..	..	..	10X	..	X	33
	90	½X	½X	..	..	..	..	..	..	10X	..	X	30
	91	X	..	..	X	..	..	..	..	..	..	X	80
	92	½X	½X	..	X	..	..	..	..	..	..	X	53
	93	½X	½X	X	X	..	..	..	..	..	..	X	43
	94	..	X	X	..	..	..	7X	..	..	..	X	28
	95	..	X	X	..	..	2X	..	..	..	..	X	18
	96	..	X	X	..	..	..	..	..	10X	..	X	28
	97	X	..	..	..	..	..	X	..	..	..	X	60
Series F—August 6	98	X	..	..	..	..	..	..	..	..	X	X	9
	99	X	..	..	X	..	..	..	..	..	X	X	40
	100	X	..	X	X	..	..	..	..	..	X	X	6
	101	½X	½X	..	X	..	..	..	..	..	X	X	14
	102	X	..	..	..	..	..	7X	..	..	X	X	12
	103	½X	½X	..	..	..	..	7X	..	..	X	X	18
	104	X	..	..	..	..	2X	..	..	..	X	X	27
	105	½X	½X	..	..	..	2X	..	..	..	X	X	11
	106	X	..	..	..	..	..	..	..	10X	X	X	18
	107	½X	½X	..	..	..	..	..	..	10X	X	X	19
	108	X	..	X	..	..	..	..	..	..	X	X	3
	109	½X	½X	X	..	..	..	..	..	..	X	X	19

Seven out of the ten records varied from the average by less than 20 per cent while three varied by between 25 and 40 per cent. The average number of the insects included in the ten records was 72 and the average variation was 11.2 or 15.5 per cent. In view of these results it is considered that there is little if any significance in differences between any two baits amounting to less than 25 per cent when the number of hoppers included in the record is less than 100. Further it is evident that even with a greater percentage of difference than 25 or with more than 100 of the insects, there is still a chance that the results from any one experiment may be misleading.

The results of the 109 experiments included in series A to F inclusive

are presented in Table I. In this table where a numeral, as ½ or 2, precedes the X a different proportion of the ingredient is indicated than is called for by what we may term the standard formula. This formula includes 25 pounds of bran, 5 lemons, 2 quarts of molasses, 1 pound of Paris green and water to make a crumbly mixture. In the molasses column, therefore, 2X indicates that the molasses was used at the rate of 4 quarts to 25 pounds of bran and in the lemon column 1½X indicates that the equivalent of 7½ lemons to 25 pounds of bran was used. Five was selected as the number of lemons for the so-called "standard formula" inasmuch as the number usually recommended is either four or six and the average appeared to be the most suitable number for the purposes of the experiments.

Fruits

In Series A, finely ground lemons, oranges, tomatoes and canteloupes were compared. The smallest number of hoppers was recorded for the lemons (47) and the highest for the canteloupe (184). The comparative rank of the four fruits are shown in Table II. In a test supplementary to Series A ground lemon and orange was exposed in watch glasses, five with each fruit alternating in a row. Five records were made of the grasshoppers found eating the fruit, the observations being at 15-minute intervals. Only 10 of the insects were recorded at the lemon while 45 were recorded at the orange.

Table II—Comparison of Fruits and Fruit Combinations, Including the Data in Series A, B, C, E and F which may Properly be Considered in this Connection

Fruit or Fruit Combination	A	B	C	E	F
Lemon	1*	1*	..	1*	1*
Orange	2	1.16	1*	.9	..
Canteloupe	4	1.18	1.85	1.13	1.15
Tomato	2.3	1.3	1.07	.8	1.9
Peach	..	1.03	..	..	..
Watermelon	..	..	..	.63	1.85

* For the purpose of comparison the unit value is given to lemon except in Series C which included no lemon combinations.

In Series B the bait combinations were used with fruits compared with lemons at the rate of 5–25, *i. e.*, 5 lemons with 25 pounds of bran. These records including 2,101 hoppers show an apparent, though no doubt negligible advantage of other fruits over lemon which is again given a valuation of 1 in the table.

In experiments numbers 36, 44 and 46 of Series C, orange, canteloupe

and tomato were used at a rate, by weight, equivalent to 10 lemons to 25 pounds of bran. In the table the orange was given the value of 1 for purposes of comparison.

In Series D will be found a comparison between canteloupe and tomato and canteloupe and watermelon. In experiments numbers 61, 63, 65 and 67 a total of 191 hoppers were recorded at canteloupe combinations and 169 at tomato combinations, a negligible difference apparently. In numbers 66 to 76, exclusive of 67, canteloupe and watermelon combinations are comparable.[1] The total hoppers recorded for the canteloupe was 339 and for the watermelon 337.

Series E affords a comparison of canteloupe, tomato, orange, watermelon and lemon used in amounts varying according to their cost in the local market. As a matter of fact nearly every farmer in the Salt River Valley and other irrigated sections of the Southwest can secure without expense cull canteloupes, watermelons or tomatoes of good enough quality for use in grasshopper baits. The total number of hoppers recorded in the experiments which can be grouped for fruit comparisons was 870. The comparative rank is shown in Table II. It should be noted that canteloupe in three other experiments in this series, used at the 5–25 rate as a check, was unusually low, ranking as .74. This is the only instance in these experiments when canteloupe combinations did not have a somewhat better record than lemon or orange.

Series F consists of a field test on a small scale of baits containing Paris green. The mixtures were applied to areas of approximately 1/100 acre each, the fruits being used on the basis of the market value as in Series E. The records refer to the number of dead hoppers counted in each poisoned area. This, however, was found not to be a satisfactory basis for comparison since only a minority of the hoppers died within the poisoned area. As they stand the records show a total of 200 dead hoppers counted, or an average of 16⅔ to each plot, the different fruit mixtures ranking as indicated in Table II. It should be noted that two other mixtures without fruit were used, bran, molasses, water and Paris green ranking as 1.1 and bran, water and Paris green as .45, the lowest of all in the Series.

In regard to the amount of fruit to be used in the poisoned bait these experiments are far from conclusive. In Series A the results showed no advantage in increasing the rate at which lemons were used from 2½ to 5 and to 7½ with 25 pounds of bran. With the lowest rate, No. 12, 65 hoppers were recorded at the bait while the average for two experiments at the 5–25 rate and one at the 7½–25 rate was 67

[1] The watermelon combinations differ from those of the canteloupe in having molasses in two instances and in having a double standard amount in two instances.

hoppers. In Series C, tomato at standard rate shows 137 hoppers whereas at the double rate only 105 were recorded. Half and half bran and sawdust with orange at the standard rate has 82 hoppers recorded whereas the same mixture with the rate doubled also has 82. Canteloupe at the standard formula rate in Series D has a total of 100 grasshoppers while the same combination with the canteloupe doubled has a total of 91. When the proportion of watermelon was doubled in the same series the records show a gain from 113 to 134. In Series E multiplying the proportion of canteloupe by seven (compare 77, 87 and 97 with 78, 79 and 80) at first appears to have given appreciable results, the smaller amounts of the fruit showing a total of 131 hoppers and the large amounts 198, an increase of 51 per cent. This apparent gain is probably due for the most part to the canteloupe combination at the standard rate having an unexpectedly low record. It is evident that these experiments are of only indirect value in indicating the amount of fruits of the various kinds which can be used with advantage in grasshopper baits.

Molasses

Grouping all of the experiments in each series which can be compared with regard to molasses[1] we find the results summarized in the following table:

TABLE III—COMPARISON OF GRASSHOPPER BAITS WITH AND WITHOUT MOLASSES

Series	No. Hoppers at Baits with Molasses	No. Hoppers at Baits without Molasses
A	182	116
B	870	924
C	433	426
D	425	384
E	196	205
F	9	49
Total	2,115	2,104

It will be noted that the baits with molasses lead three times and the baits without molasses lead three times. The difference in the totals is negligible, being less than one half of one per cent.

A comparison of citrus fruit baits with and without molasses is of special interest. Both lemon and orange baits have better records where no molasses was used, the figures being 340 and 269 for the lemon baits and 408 and 316 for the orange baits. Both citrus fruits com-

[1] The molasses known as "Black Strap" was used in all cases where indicated.

bined have a total record of 748 hoppers where no molasses was used and 588 where molasses was included.

In Series G, a bait made according to the standard formula modified by using one extra lemon and omitting the molasses, was applied to one fifth acre of alfalfa and a similar bait including molasses at the usual rate was applied to a nearby plot of the same size where the grasshoppers appeared to be equally numerous. After three days the dead hoppers were counted in a square area of 100 square yards located centrally in the fifth acre plot. A total of 234 dead hoppers were found where *no* molasses was included in the bait and only 68 in the plot where the bait contained molasses.

Owing to the movement of the adult grasshoppers after eating a fatal dose, the figures for Series F and G cannot be given full value except as evidence that the use of molasses in the baits for the differential grasshopper did not increase the effectiveness.

Sawdust[1]

A summary of the tests in which bran may be compared with pine sawdust in the several combinations shows that the sawdust was inferior to bran. For the sawdust combinations 405 hoppers were recorded whereas 781 were recorded for the corresponding bran combinations. The former therefore gave only 52 per cent efficiency as compared with the latter. When mixed with bran in half and half mixtures, however, results were obtained which were practically the same as for the straight bran combinations, the half and half mixture having 724 hoppers recorded while the bran combinations have 697 or approximately 4 per cent less.

Sawdust and Canteloupe in Field Tests

A cotton grower located near Phoenix whose crop was being damaged by the differential grasshopper, at the writer's suggestion substituted a pound of canteloupe for the lemons ordinarily used with 25 pounds of bran. The results were reported to be entirely satisfactory, the grower finding dead hoppers in large numbers while few live ones remained. The report was convincing in its detail but was not verified by the writer. On August 19 Mr. Fisk, one of the writer's assistants, poisoned a thirty-acre alfalfa field using the 4–25 bran-lemon formula[2] in comparison with two mixtures containing half and half bran and sawdust. One of these (B) was identical with the 4–25 formula except that the half and half bran and sawdust mixture was substituted for the

[1] The testing of sawdust was suggested by experiments conducted in Canada in 1915. Forty-sixth Ann. Rept. Ent. Soc. Ontario.

[2] Bran 25 lbs., lemons 4, molasses 2, Paris green 1, water as needed.

bran. The other (C) consisted of a mixture like B with one pound of canteloupe substituted for the four lemons. The standard bran-lemon formula was used in treating 5 acres. Formula B was used for treating two ten-acre sections and formula C in treating 5 acres. The number of grasshoppers per square yard varied considerably in the different sections but in the area treated with each kind of the poisoned mash there were from two to three acres where the insects varied from 15 to 50 per square yard. Four days after making the application it was estimated by Mr. Fisk that from 80 to 85 per cent of the hoppers were dead throughout the field. The results from the use of baits made with the bran-sawdust mixtures were estimated to have been fully as good as those from the standard bran-lemon formula.

In southern Arizona during the season when the differential grasshopper is most destructive, canteloupe is usually available as a substitute for the lemons. Overripe or cull canteloupes which can be obtained without cost as a rule are as good as any. Sawdust sells for ten cents a sack of about 35 pounds. The substitution of canteloupe for the lemons and of sawdust for half of the bran in the standard formula reduces the cost of the bait 20 per cent. If field tests confirm the results of the observations reported in this paper in regard to the value of molasses in bait used against the adult differential grasshopper, the elimination of molasses will reduce the cost of the bait an additional 17 per cent.

The bran available in Arizona contains a large proportion of fine material and the use of a third to a half sawdust gives a mixture which is much easier to distribute in the field. Even though the sawdust decreases the attractiveness of the mixture this disadvantage evidently would be offset by its better distribution.

Distance Poisoned Grasshoppers Travel

In testing poisoned baits it is sometimes important to know how far grasshoppers may travel after eating a fatal dose of the poison. In Series G, poisoned baits were applied in an alfalfa field to 5 plots 30 yards square. The plots were located in a row alternating with plots of equal size which were not poisoned. It was believed that by counting the dead hoppers in a square 5 yards on a side located centrally in each of the poisoned plots the effectiveness of the baits could be determined. This method proved a complete failure and consequently a second count was made within a square plot 10 yards on a side. In the 5 plots the smaller squares (5 x 5 yards) averaged 23 dead hoppers or an average of a little less than one per square yard. Contrary to expectations the space between the inner squares and the boundaries of the larger squares (10 x 10 yards) averaged 1.3 dead

hoppers per square yard. There was a very striking migration of poisoned hoppers from the poisoned plots toward eucalyptus and cottonwood trees forming a broken row along one side of the field. The poisoned plot at the south end of the row had a total of 234 dead hoppers in the 100 square yards of space above mentioned. Beneath a tree standing in the southeast corner of this plot 364 dead hoppers were counted. Due south of this tree were four others, 31, 54, 66 and 78 yards distant respectively. Eight poisoned hoppers were found beneath the first, three beneath the second and three beneath the third. None were found near the tree which was 78 yards distant from the poisoned plot. In another experiment where there were no trees to attract the poisoned grasshoppers, 40 of the dead insects were counted in a poisoned plot 7 yards square. Within 10 yards north of the north border there were 20 dead hoppers, between 10 and 20 yards there were 14 dead hoppers, between 20 and 30 yards 12 dead hoppers. None were found more than 27½ yards from the poisoned plot.

Relation of Time of Day to Feeding of Adult Grasshoppers

In the course of the bait tests reported in this paper records were secured which tend to show that in alfalfa fields the adult differential grasshoppers feed most actively during the warmer parts of the day and less actively toward night. By segregating the records which began at 3 p. m. and extended to 6.45 the following table has been arranged:

Table IV—Relation of Time of Day to Feeding of Grasshoppers*

Date	Exp. Series	3–3.45	4–4.45	5–5.45	6–6.45
July 27	B	128	84	56	21
July 30	C	150	143	58	43
July 31	D	68	50	37	18
Average		115.3	92.6	50.3	27.3
Per cent		40.4	30.3	17.6	9.5

* The figures represent the average of four observations taken on the hour and quarter hours.

The total number of hoppers included in the records was 3,382. These records are entirely incidental and it should be said that no effort was made to determine definitely whether the attractiveness of the baits in the pans remained constant throughout the periods when the records were made. It is the writer's opinion, however, based on general observations, that decreasing attractiveness of the baits was not an important factor in the results.

In demonstration work one of the most effective applications of bran mash which the writer has ever observed was put out in a cotton field on July 3, 1917, between seven and eight o'clock in the morning. We have usually recommended that the bait be put out as soon after daybreak as possible and in general our observations in Arizona show better results from early morning applications than from applications made late in the afternoon. The data summarized in the foregoing table suggests that bait for the differential grasshopper may be spread with good results during the warmer part of the day up to 3 or 3.30 p. m. Working with another species of grasshopper (*Eucoptolophus subgracilis* Caudell) near Yuma, Arizona, on October 20, 1917, and a few days following, Mr. J. L. E. Lauderdale reports good results in killing the hoppers with bran mash applied between 3 and 3.30 p. m.

Amount of Alfalfa Consumed by Grasshoppers

There are times when farmers hesitate to spend forty or fifty cents an acre for materials with which to poison grasshoppers. In our work in Arizona a need was felt for a definite basis for estimating the daily damage done by these pests. Consequently two tests were conducted (July 18–20, 1917) with adult specimens of the differential grasshopper in order to determine the capacity of this species for destroying alfalfa.

In the first test 50 adult specimens were used. A lot of freshly cut alfalfa weighing eight ounces, with stems in a bottle of water, was placed in a wire screen cage containing the grasshoppers and a check lot of alfalfa was placed in a nearby cage. Twenty-four hours later only 37 of the 50 insects could be found in the cage. The two lots of alfalfa were weighed and the amount of green alfalfa destroyed by the hoppers was computed. It was found that the check had decreased 18.2 per cent in weight while the lot on which the insects fed decreased 38.8 per cent. The net difference in weight was 44.87 grams. Assuming that the 13 missing specimens averaged twelve hours in the cage before escaping, the average amount of green alfalfa destroyed by the hoppers was approximately one gram. Of this about $6\frac{2}{3}$ milligrams consisted in leaves and tender stems which were severed and had dropped to the ground. At this rate an average of 7.56 adult hoppers per square yard would be capable of consuming green alfalfa which would be equivalent to 1/100 of a ton of alfalfa hay per acre or one ton for 100 acres.

In the second test 25 adult specimens were used and as all were accounted for at the end of twenty-four hours the data obtained is more satisfactory than in the first test. The amount of green alfalfa destroyed averaged 1 2/5 grams for each insect. At this rate an average of 6.3 adult hoppers per square yard would destroy green alfalfa

equivalent to 1/100 ton of hay. Using this as a basis we may figure that an average of one hopper per square yard may destroy the equivalent of three pounds of alfalfa hay per acre per day. In a forty-acre field a moderate infestation averaging 16⅔ hoppers per yard may destroy the equivalent of one ton of alfalfa hay per day. We may also figure that at present market values for alfalfa hay in Arizona, the cost of using poison bait is considerably less than the damage done in a single day by adult differential grasshoppers occurring at the rate of 16⅔ per square yard. It is evidently very profitable to poison the hoppers even when they average as few as 5 per square yard.

It is unnecessary to say that calculations of this kind prove very effective in connection with demonstration work in grasshopper control, particularly when the infestations are not conspicuously heavy.

President R. A. Cooley: Do you wish to ask Dr. Morrill any questions or to discuss this contribution?

The points covered by Dr. Morrill are certainly of much interest and very valuable in practical work in the field among farmers. We learned that this past season in our grasshopper experiences. I am particularly glad that this work was undertaken.

The next paper is by Mr. W. P. Flint, of Illinois—"A New Method of Combating the Chinch-Bug."

SUGGESTIONS FOR A NEW METHOD OF DESTROYING CHINCH-BUGS

By Wesley P. Flint, *Assistant, State Entomological Survey*

This paper is given not with the idea of showing the results of a finished series of experiments, but as suggesting a possible new point of attack on one of our most destructive grain insects.

During field operations against the chinch-bug in Illinois, when immense numbers of these insects had been confined for some days in dry stubble fields, it was noticed that they would collect in large numbers on any moist object or on the ground where water had been spilled. A close examination of a large number of chinch-bugs that were gathered on a moist gunny sack used to protect a water jug showed that nearly all had their beaks inserted in the sack and were apparently sucking the water from it. From these observations it seemed possible that chinch-bugs might be killed if they could be induced to feed on some substance which was moistened with water containing some soluble poison.

During the winter a number of experiments were made in which adult chinch-bugs taken from their hibernating quarters were placed in large open boxes in the laboratory. The sides of these boxes were chalked to prevent the escape of the bugs, and small masses of bran wet with a solution of sodium arsenite at different strengths were placed in some of the boxes, and bran and water in others. The results of these experiments proved that at moderately high temperatures the bugs would collect on the bran and suck the moisture from it. A very high percentage of those in the boxes containing the bran wet with the sodium arsenite died in a few hours, while those in the checks lived for a number of days. Attempts to make the bran more attractive to the bugs by adding corn syrup to the solutions were without results.

During the spring of 1917, further experiments along this line were made in the field. A wheat-field of about fourteen acres, moderately infested with chinch-bugs, was selected for this work. As soon as the wheat was cut, a barrier was made around the field by cleaning a narrow strip of all vegetation and pouring on this a line of crude creosote. A number of substances wet with solutions of sodium arsenite, lead acetate, and sodium cyanide at strengths of from ½ ounce to 2 ounces per gallon of water, were placed along the inside of this barrier, where large numbers of bugs were sure to come in contact with them.

The solutions of sodium arsenite were not found very effective at any of the strengths tried. This substance in solution seemed to have a slightly repellent effect on the chinch-bugs.

Solutions of sodium cyanide were effective in killing large numbers of chinch-bugs, but more from the effect of the fumes than as a stomach poison. Such solutions would be too dangerous to handle to recommend for general use.

Solutions of lead acetate at 2 ounces to 1 gallon of water proved the best of any of the poisons tested. Fresh corn stalks cut and dried for several days were soaked in a solution of lead acetate at the above strength, spread along the ground just inside the barrier, and covered lightly with straw to prevent rapid drying. After twenty-four hours there was an average of 104 dead chinch-bugs to the square inch under this material. The dead bugs were removed each morning, but the stalks were not wet with the poison solution for seven days. On the sixth day there was an average of 11 dead bugs to the square inch under this line. This experiment was repeated five times with approximately the same results. A solution of lead acetate at 2 ounces to 1 gallon of water was placed in a mason jar sunk in the ground, and a wide lamp wick, twenty-four inches long with one end in the solution, was laid along the ground and lightly covered with straw. It was only possible to keep this wet for about twelve to sixteen inches.

After twenty-four hours 603 dead chinch-bugs were counted in a space two inches square on and beside this wick. This remained effective as long as the wick was kept moist and the weather continued dry. Rains had the effect of greatly lessening the number of bugs killed.

A device sold generally for poisoning flies, known as "The Daisy Fly-killer," and containing "metallic arsenic," according to the label, was placed on the ground near the barrier and lightly covered with straw. This apparatus consisted of a shallow tin box about three inches one way by two the other, with a number of perforations in the top through which insects could get access to the poison solution which it contained. It was kept in place for six days, and an average of 300 dead chinch-bugs per day were found on and immediately around it.

Attempts to make the solution of lead acetate more attractive to the chinch-bugs by adding the juice of freshly crushed corn stalks, were without results. Bran, corn silage, the very dry refuse corn stalks from the feed lot, wheat straw, and weeds, were all tried as carriers for the poison solutions. Only the corn silage and bran proved of any value, and these were not as attractive to the bugs as the freshly cut and dried corn stalks.

Although these experiments have not been carried to a point where any of the facts learned from them can be applied in field practice in combating the chinch-bug, and possibly no such application can be made, they have at least shown that it is possible to kill chinch-bugs in large numbers by the use of soluble poisons, and may prove of value in our fight against this insect.

Urbana, Illinois,
December 18, 1917.

Adjournment.

Afternoon Session, Wednesday, January 2, 1918, 1.20 p. m.

President R. A. Cooley: We will take up the next number on the program, which is "Some Results of Two Years' Investigations of *Dermacentor venustus* Banks in Eastern Montana," by Mr. Parker, of Montana.

SOME RESULTS OF TWO YEARS' INVESTIGATIONS OF THE ROCKY MOUNTAIN SPOTTED FEVER TICK IN EASTERN MONTANA [1]

By R. R. PARKER, *Bozeman, Mont.*

Until 1915 the occurrence of Rocky Mountain spotted fever in eastern Montana was thought to be limited to Carbon County. Though this is now known to be untrue, still the spring of 1915 was the first in which the disease was sufficiently prevalent to attract marked attention. The infected territory included most of the eastern counties, particularly the central and southern. So many cases appeared and in such a large area that a brief survey of conditions was undertaken. The need for extensive research was immediately apparent. Intensive studies were carried on at Powderville in southern Custer County in 1916 and at Musselshell in Musselshell County in 1917, infection having existed at both localities. Trips to other localities and correspondence have increased the comprehensiveness of the work.

The character of the country was found to have a fundamental influence on the abundance of ticks and a brief statement of conditions is necessary before proceeding. Though there is some variation, the greater part of the country conforms to two types,—the prairie type and the hill type. In the former the country is very bare, sage brush and prairie grasses the predominant plant life, while tree growth is mainly confined to the river banks. The Powderville studies were carried on in this sort of country. The work at Musselshell, however, was in the hill type. There the formation consisted of hilly, pine-wooded areas separated by narrow valleys, from which much narrower, many branched coulees extended far back into the hills. The valleys and hills were joined by very steep, rocky slopes, that were frequently wooded.

ABUNDANCE OF TICKS.—One of the first observations of importance was that in most regions ticks are really numerous only during occasional seasons. The year of 1915 was one of great abundance in many places. Occasional areas are found included in the prairie type, however, where ticks are either abundant each year or at least at more frequent intervals than on the prairie itself. Such areas are usually small and the difference in the abundance of ticks is due to changes in the fauna dependent on highly localized changes in the vegetation. A good example is furnished by the U-shaped bends of the Powder river where the enclosed land frequently is heavily wooded and there

[1] Contribution from the Montana State Board of Entomology.

is abundant underbrush. Such places are exceedingly favorable for the increase of certain species of tick hosts, which, under prairie conditions, are never numerous enough to be of importance.

WILD MAMMALS AS TICK HOSTS.—The conclusions regarding the importance of various wild mammals as tick hosts are based on the examination of 1,703 animals belonging to about 30 species. Under prairie conditions 11 species were found to be hosts of larval and nymphal ticks. These were jack rabbits, cottontail rabbits, deer mice, field mice, chipmunks, pack rats, kangaroo rats, striped spermophiles, grasshopper mice, prairie dogs and porcupines. Porcupines, grasshopper mice and probably prairie dogs are of little importance. On the other hand, in the hill country at Musselshell, where the country was rocky and more or less wooded, deer mice and chipmunks were the only generally distributed hosts of the immature ticks that were of any importance. Rabbits and pack rats, normally rather numerous, were very scarce in 1917, but would be factors to be reckoned with whenever abundant. Field mice were important wherever conditions favored their presence in large numbers.

As hosts of the adult ticks wild mammals were found to furnish three,—jack rabbits, porcupines and coyotes. The importance of coyotes is uncertain.

Of the animals above mentioned, jack rabbits, porcupines, deer mice and field mice are deserving of further discussion.

Jack Rabbits.—The jack rabbit merits distinction as the most important wild mammal of eastern Montana in relation to the spotted fever tick. This is due to the following reasons: first, it is the only animal known to harbor all three stages of the tick; second, according to all indications it can maintain an infestation of ticks without the presence of domestic animals; third, it is generally distributed in all parts of eastern Montana; fourth, it has a wide travelling radius; fifth, it is susceptible to Rocky Mountain spotted fever[1]; sixth, there is reason to believe that this rabbit may play an important part in the spread of the disease both extensively and intensively.

Under prairie conditions, when ticks were not at all abundant, 65 of 84 jack rabbits examined were tick infested (77.38 per cent). Fifty-six (66.66 per cent) were infested with adults. This was an average of 1.87 adults per rabbit, whereas the average for horses examined during the same period was 1.44. The greater percentage of females on horse, however, would probably more than discount the numerical superiority in favor of the rabbit, and in years of real tick abundance

[1] This has been demonstrated by work recently carried on at the Harvard Medical School under the direction of Dr. S. B. Wolbach, who has lately contributed greatly to the knowledge of the etiology and the pathology of the disease.

the horses would undoubtedly show the higher average. Jack rabbits are especially efficient as nymphal hosts, the latter engorging in much less time than on any other animal and may be present in large numbers. Cottontail rabbits are also important, but principally as hosts of the immature stages; and it is likely that they are susceptible to the disease.

Interesting observations of the past two seasons have pointed to a frequent coincidence of the abundance of ticks and the abundance of jack rabbits preceding the occurrence of cases of the fever. It is well known that in many regions rabbits will suddenly increase greatly after several years of relative scarcity and then after a few years of abundance will as suddenly die off, due to causes not well understood. The intervals between the epidemics are variable but seven years has frequently been recorded, though it may be more or less. At Powderville rabbits reached their maximum abundance in 1914 and died off in great numbers during the winter of 1914 to 1915 and for some time thereafter. The latter year was that of great tick abundance and also that in which several cases of fever occurred in that region. It is not desired to direct attention to the possible influence of rabbits on the periodical abundance of ticks, however important that may be, but rather to point out that a periodic increase in rabbits means a periodic increase in an animal highly susceptible to spotted fever, and when it so happens that an increase in ticks is coincident, it is reasonable to suppose that if infection is present in nature, then a considerable increase in the number of infected ticks becomes possible. The occurrence of fever following a parallel increase in rabbits and ticks, therefore becomes of interest. The data indicate the possible control of spotted fever under eastern Montana prairie conditions by the eradication of rabbits: conclusive evidence will be sought in our future field operations.

Porcupines.—Several of these animals examined under prairie conditions late in the season of 1916 were infested with adult ticks, one a fully engorged female. The likelihood that they might be important adult hosts has since been strengthened by emphatic statements by ranchers and further observations. More than 20 adult ticks have been found on a single animal and a seasonal average of 6.8 was obtained in 1917. Where numerous these animals are surely of some importance.

Deer Mice.—Next to the jack rabbit, the deer mouse is certainly the most important wild mammal in eastern Montana, considered as a whole, in relation to the tick. The reasons for this are,—first, it far exceeds in abundance all other wild mammal hosts of immature ticks combined, second, its wide distribution and its adaptability to all

sorts of conditions, third, the fact that it is a most efficient host of larvæ and nymphs. The degree to which these mice are infested depends largely on the combination of conditions present in any locality. Every variation may be found from the locality where an infested mouse is a rarity to that in which all are infested. For example, in the Musselshell operations, 54 mice taken on a certain homestead at various times during the season were all uninfested, whereas 9 mice taken in a badly infested coulee on August 5 averaged 19.88 ticks each, and 5 taken in a similar location on August 23 averaged 19.40. As many as 125 ticks have been taken from a single mouse, 39 of them fully engorged. The average infestation for 307 mice taken under prairie conditions was .19 (in a poor tick season), that for 343 mice under hill conditions 1.25. In prairie country these mice were found in every conceivable sort of place, while under the hill conditions studied they were abundant only on the rocky slopes along the edges of the valleys.

Field Mice.—The possible importance of field mice was suggested by the work on the prairie where the average infestation was found the same as for deer mice. Under hill conditions more definite data were secured. For 26 mice examined during 1917 the average of larvæ and nymphs was 5.15. The average for 9 taken from a badly infested coulee on August 5 was 10.73. The high seasonal average in 1917 does not mean that they are in any way comparable to deer mice as hosts. They are not. It is only where very favorable habitat conditions occur, and this is not frequent, that they are of importance. Where this is the case, however, they are a factor to be reckoned with.

One may easily be deceived as to the importance of mice unless great care is used. Suspecting that such was the case observations were made which showed that the great majority of deer mice get into traps before 11 o'clock at night and most field mice much earlier. The ticks are therefore afforded ample time to leave the host even though the traps are collected early in the morning. The precaution of examining the ground around each trap has not only greatly increased the value of our records, but has also made it evident that the figures given are too low.

As to domestic animals as hosts of adult ticks there is little of definite value to add to the facts learned in the Bitter Root. There is some difference in habits as regards the points of attachment to the host. It was discovered, however, that pigs running at large will pick up large numbers of ticks, a fact of some interest. Tabulation of data for 1917 shows that horses, cattle and pigs are efficient as tick hosts in the order named. The records show that of the ticks taken from

these animals in the order given, the per cent of females showing engorgement was 74.42, 60.93 and 24.61; the per cent over .5 engorged was 3.86, 1.75 and 0 (average per animal .29, .11, .00); and the per cent over .8 engorged was 2.70, 1.46 and 0 (average per animal .29, .20 and 0). No females more than .2 engorged were found on pigs.

It is of interest to compare some of the facts given above with those which govern the control system used in the Bitter Root Valley. Control there is dependent on the facts that adult ticks are essentially confined to domestic animals and that the Columbian ground squirrel is by far the most important small mammal as host of larval and nymphal ticks. In eastern Montana, on the other hand, the adults are not confined to domestic animals but the jack rabbit is also an exceedingly important host, with the porcupine as an able accessory. Also instead of one small and easily controlled mammal as the most important host of the young ticks, we find several efficient hosts, their relative importance frequently depending on local conditions. Mice, seemingly of scant importance in the Bitter Root, are one of the important problems in the east.

Relation of the Character of the Country to the Abundance of Host Animals and of Ticks.—A thorough comprehension of the tick problem in eastern Montana, and probably in many other places where the milder type of the fever occurs, involves an accurate knowledge of the effect which the character of the ground and the floral setting has on the abundance of the tick, and the reasons therefor. Other factors being favorable, the abundance of ticks depends to a large extent on the character of the ground, whether rocky or clear, and upon the nature of the vegetation. It is these factors which determine the species of host animals and their *relative* abundance. For example, in a prairie country, only prairie animals, of which the jack rabbit is one, can become really numerous, while species such as the chipmunk that are not adapted to such conditions can never become sufficiently numerous to be a real factor in tick abundance. Another example is furnished by the conditions existing in the hill country. There the ticks were found largely confined to the rocky slopes between the valleys and the hills and in the coulees. This was because it was in these places that the deer mice and chipmunks, previously mentioned as the important hosts of that region, found the most favorable habitat conditions. Whenever ticks were numerous under other conditions it was explainable by the presence of other host animals adapted thereto. Mention has already been made of the fact that field mice were of importance only where conditions particularly favored them. It has also been found that certain animals which, under prairie conditions, are found both in rocky places and in rock free areas, always

yield the most ticks when taken in the rocky situations. These facts are interesting and important.

The writer wishes to acknowledge the valuable aid of his assistant, Mr. R. W. Wells, in conducting the studies upon which this paper is based.

President R. A. Cooley: This paper is before you. Do you wish to ask questions or make contributions on the same subject?

Mr. F. C. Bishopp: Dr. Parker's discoveries in eastern Montana are exceedingly interesting to me. I believe probably the most important bearing is that the facts he has found out there will be more or less applicable to the large area of the country infested by the spotted fever tick and where the disease occurs, notably: Idaho, Nevada, parts of California and I might say parts of Montana and Colorado.

The work that has been done heretofore, as you probably know, has been confined largely to eastern Montana, where we have a special set of conditions and control matters worked out there are very clearly, as shown by Dr. Parker, not entirely applicable to conditions elsewhere in the West.

We have examined a good many jack-rabbits in different parts of the country and our experience has been that we seldom, if ever, find the female tick and it is our opinion that most of the ticks are dislodged on the jack-rabbits before they become full grown.

Mr. R. R. Parker: We found them more or less on horses.

President R. A. Cooley: Is there any further discussion? If not, we will call upon Mr. Wood for his paper on "Sodium Fluoride—A Specific for Biting Lice."

SODIUM FLUORIDE—A SPECIFIC FOR BITING LICE

By F. C. Bishopp and H. P. Wood, *Dallas, Tex.*

(Withdrawn for publication elsewhere)

President R. A. Cooley: Is there any discussion? If not, we will pass on to the next paper, "Mosquito Flight as a Factor in the Problem of Control," by Mr. Headlee, of New Brunswick, New Jersey.

MOSQUITO FLIGHT AS A FACTOR IN THE PROBLEM OF CONTROL

By T. J. Headlee, *New Brunswick, N. J.*

(Withdrawn for publication elsewhere)

PRESIDENT R. A. COOLEY: Do you wish to ask Dr. Headlee any questions or to discuss this paper?

It has been of particular interest to me to listen to this paper, because we are beginning to undertake mosquito work in Montana and the problem of migration is particularly acute in that state.

I believe there are some interesting points in the paper which Professor Cockerell sent on and the Secretary is going to review one or two of them.

THE MOSQUITOES OF COLORADO

By T. D. A. COCKERELL, *University of Colorado*

More than a dozen years ago, when I was resident at Las Vegas, New Mexico, a prominent army medical officer appeared in town, to investigate the neighborhood as a possible site for a camp to which soldiers from the Philippines or the West Indies might be sent. The local merchants, always keen to extend their trade, wished to do everything possible to encourage the project. The officer, however, asked to see an entomologist, who might inform him whether *Anopheles* existed in the vicinity. I was accordingly called in, and testified that while I had met with *Anopheles* in the southern part of New Mexico, I had never seen any about Las Vegas. Scarcely had the officer departed, when I found *Anopheles* larvæ almost under the windows of the big sanitarium at Las Vegas Hot Springs. It was of course my duty to inform the army authorities, but I was rather relieved to hear that before my letter came it had been decided on quite other grounds not to place the camp at Las Vegas. The *Anopheles* was bred, and proved to be *A. pseudopunctipennis* Theob., quite new to that part of the world.

This year the same general problem presented itself in another form. In the course of the war, it will be necessary to establish a number of recuperation camps, and of course these must be situated in the most favorable localities. On account of frequent infection with tuberculosis, the drier regions of the west will prove especially beneficial. The malaria problem will be less important, but the absence of *Anopheles* is to be desired, to say the least. It will also be very desirable to place the camps reasonably close to commercial centers of distribution, so that food and other materials may be obtained without undue cost. On all these counts eastern Colorado, with portions of adjacent states, may be especially recommended. I mapped the recorded distribution of *Anopheles* from the data in the great work of Howard, Dyar and Knab, and found that the genus existed practically all over the United States, excepting apparently an area including eastern Colorado,

Wyoming, Nebraska, the Dakotas, and some adjacent regions. It is not probable that *Anopheles* is actually absent from all this area, but even if locally present it can often be readily exterminated, owing to the limited possible breeding places. It was obvious, however, that our knowledge was extremely incomplete, and it seemed desirable to determine the actual facts relating not merely to *Anopheles,* but to the Culicidæ of the region generally. With this purpose in view, a mosquito survey of Colorado was begun this year. It was also planned to include Wyoming, from which it appeared that only one species (*Aedes nigromaculis*) was recorded, and collections were made in several localities. I recently learned, however, that Dr. John W. Scott and Mr. O'Roke of the University of Wyoming had taken up the Culicidæ of their state, and consequently we shall restrict ourselves to Colorado, merely presenting below the few Wyoming records already obtained. So far as recorded by Howard, Dyar and Knab, the Culicidæ of Colorado number seven species, referable to *Anopheles, Culex, Aedes* and *Theobaldia.* The material came from nine localities. Our own collections, prior to 1917, were of little value. During the past summer Professor Junius Henderson of the University of Colorado made two long trips in a Ford car, the first in Colorado, the second in Wyoming. On these journeys Culicidæ were collected whenever possible, and the collections thus obtained greatly extend our knowledge of distribution. The localities represented are as follows:

(A.) COLORADO (J. Henderson and P. Andrews).

(1) *Eastern slope.*

(a) Pueblo County. One mile east of Avondale, June 27; Boone, 4,477 ft. alt., June 28.

(b) Chaffee County. River bottom 3 miles southwest of Salida, July 1; S. Cottonwood Canyon, west of Buena Vista, 8,500 ft., July 4.

(c) Lake County. Upper Twin Lake, about 9,020 ft., July 5; two miles south of Leadville Junction, July 6. Seven miles south of Leadville, at 9,300 ft., July 8, *Prosimulium fulvum* (Coq.) was taken.

(2) *Western slope.*

(a) Eagle County. Two miles west of Tennessee Pass, July 9; four miles above Red Cliff, 8,850 ft., July 12; Cataract Creek, east fork of Eagle River, above Minturn, July 9; two miles above Minturn, at mouth of Cross Creek, July 14; four miles above Pando, east fork of Eagle River, July 10 (larvæ and pupæ); Wolcott, 6,965 ft., August 2; six miles above Wolcott, July 16; McCoy, August 4; creek

between Gypsum and Glenwood Springs, via Cottonwood Pass road, July 16.

(b) Pitkin County. One mile southwest of Aspen, July 22; Crystal River, one mile above Red Stone, July 27.

(c) Garfield County. Three or four miles above Carbondale, July 19; 13 miles above Glenwood Springs, on Grand River, August 2; 2½ miles north of Rifle, July 25.

(B.) WYOMING (J. Henderson and E. Schwabe).

(a) Bottom lands at Basin, August 29. *Aedes nigromaculis, A. curriei* and *A. vexans*.

(b) Box Elder Creek, 19 miles west of Douglas, August 25.

(c) Shell Creek, five miles above Shell, September 2. *Aedes vexans*.

(d) Dry mesa three miles north of Ten Sleep, August 28; Creek bottom three miles east of Ten Sleep.

(e) North Platte Bridge, about 8 miles northeast of Wheatland, August 24. *Aedes* in bad condition; one at least is *curriei*, some seem to be *vexans*.

On September 6, Dr. Chas. N. Meader kindly took me in his car to visit the localities occupied by troops in the vicinity of Denver. The following were examined with some care:

(a) Camp Baldwin. Could not find any species breeding, but in a dried up marsh, among tall reeds, were great quantities of mosquitoes. We caught ten females, and all were *Aedes vexans* (*sylvestris*), which did its best to justify its name.

(b) Fort Logan. Examined all pools by the river and pond near Fort, and obtained no culicids, larvæ or adults. The weather had been extremely dry, and the river had fallen, leaving many small pools, which were, however, full of fishes and frogs. We later learned that the pools about the camp had been oiled "every now and then" by the military authorities, but on September 6 we found little evidence of oil.

(c) Rifle range, near Golden. Could not find any species breeding. Caught a ♀ *Aedes vexans* and a male *Culex tarsalis*.

Our general impression was that Culicidæ were relatively scarce in the region, and where they occurred, they could very easily be dealt with. Another species, *Theobaldia inornata*, has been taken by Tucker at Denver.

Other collections were made at Boulder, Longmont and Brainerd Lake in Boulder County. On September 9 my wife and I examined Boulder Canyon from the mouth upward a distance of over three miles. The creek had fallen recently, and small pools were left, with very young fish in them. No culicids were found breeding, nor were

any adults caught. Cattle at the mouth of the canyon had no culicids on them, but were plentifully infested by the horn-fly, *Hæmatobia serrata*.

The species so far definitely identified from Colorado or Wyoming are the following:

(1) *Anopheles quadrimaculatus* Say. Recorded only from the far western part of the state, at Hotchkiss and Delta in Delta County, where it was taken by G. P. Weldon, as is recorded by Howard, Dyar and Knab. We have so far found no trace of *Anopheles* in our collections. In the vicinity of Grand Junction, which is still nearer the western border, E. P. Taylor obtained four species of Culicidæ, but they were *Theobaldia incidens, Culex tarsalis, Aedes curriei* and *A. vexans*.

(2) *Culex tarsalis* Coq. Common at low altitudes, up to about 6,000 ft., but not in the high mountains. It is particularly abundant at Boulder, coming into the University buildings. It is the only mosquito at present recorded from Colorado Springs.

(3) *Culex pipiens* L. Recorded from Denver by Tucker in 1907, but the record needs confirmation. It was supposed to have been determined by Dyar, but Mr. Knab states that the determination must have been by Coquillett.

(4) *Theobaldia inornata* Willist. Common at Boulder; also collected at Denver and Florissant, and by Philip Andrews at mouth of Cross Creek, two miles above Minturn. The altitudinal range in Colorado is about 5,000–9,800 ft., so far as ascertained.

(5) *Theobaldia incidens* Thoms. Recorded from Grand Junction (E. P. Taylor), and Henderson and Andrews took it in S. Cottonwood Cañon, near Buena Vista. It is decidedly less common with us than *T. inornata*, and seems not to go so high in the mountains.

(6) *Aedes acrophilus* Dyar. Dr. Dyar has determined this from females and larvæ; the male is unknown. I had regarded the species as a new one near *pullatus*, but at the time the description of *acrophilus* (Ins. Ins. Mens. 1917, p. 127) from Alberta was being printed. Our localities are: females from a mile southwest of Aspen; S. Cottonwood Cañon, near Buena Vista; Cataract Creek, near Minturn; two miles west of Tennessee Pass. Larvæ from four miles above Pando, East Fork of Eagle River, July 10 (P. Andrews). It is a mountain species in Colorado, belonging especially to the Canadian Zone.

(7) *Aedes aldrichi* Dyar & Knab. Boulder (Cockerell); I determined it as *aldrichi*, and Dr. Dyar agrees.

(8) *Aedes cinereus* Meigen. One female taken by Schwabe and Henderson at Box Elder Creek, 19 miles west of Douglas, Wyoming. I took it for a new species, on account of the bright ferruginous thorax, with three very faint dorsal dusky stripes. Very possibly it represents a subspecies, but more material is needed. Dr. Dyar assures me that it has entirely the structure of *cinereus*, and cannot possibly represent a distinct species.

(9) *Aedes curriei* Coquillett. Common at lower altitudes in Colorado. Recorded from Grand Junction and Florissant, I have it from Boone, Boulder (it occurs on the University Campus), Grand R. above Glenwood Springs, Longmont, 2½ miles north of Rifle, and Wolcott. The specimens from Wolcott and thirteen miles above Greenwood Springs have very handsome markings, and represent the variety *mediolineata* Ludlow. In Wyoming *curriei* was taken in the bottom lands at Basin, and at the North Platte Bridge near Wheat-

land; var. *mediolineata* comes from the dry mesa three miles north of Ten Sleep. On the dry mesa near Ten Sleep the catch was 6 *curriei mediolineata* and one *vexans*, but in the creek bottom 7 *vexans* only. *A. curriei* goes to about 8,000 feet in dry localities, as at Florissant, but is absent from the Canadian zone.

(10) *Aedes idahoensis* Theob. Our form, referred to *idahoensis* by Dr. Dyar, has the abdomen banded, and looks distinct from the more typical form, with square black patches on abdomen, collected by Dyar in Montana. As we have neither males nor larvæ of the Colorado insect, the determination may be subject to revision. The localities are: three miles south west of Salida; one mile south west of Aspen; creek between Gypsum and Glenwood Springs (a small specimen); Upper Twin Lake; six miles above Wolcott; 3 or 4 miles above Carbondale; McCoy; two miles above Minturn. Several specimens from different places were examined by Dr. Dyar, and the others seem to me to be identical. I had first regarded the species as *A. hirsuteron*, which is very close to *idahoensis*, but the wing scales are not all black. In Colorado, *idahoensis* is of the Transition and Canadian zones.

(11) *Aedes mimesis* Dyar. I had regarded this as a new species; Dr. Dyar refers it to *mimesis*, described from Montana and British Columbia in Ins. Ins. Mens., 1917, p. 116. It comes from Upper Twin Lake, and four miles above Red Cliff (alt. 8,850 ft.); it is therefore a species of the higher mountains. There is a broad median brown band on thorax, in *curriei* style. The markings of the abdomen are variable.

(12) *Aedes nigromaculis* Ludlow. A species of the plains; recorded from Akron and Boulder. In Wyoming Henderson and Schwabe took it at Basin.

(13) *Aedes pullatus* Coquillett. A male which I collected at Estes Park Village (6,810 ft.), June 24, has been kindly examined by Dr. Dyar and found to be genuine *pullatus*.

(14) *Aedes sansoni* Dyar & Knab. I had determined this as *vittatus* Theob.; Dr. Dyar states that it is *sansoni*, and in Ins. Ins. Mens., 1917, p. 115, shows that *sansoni* and *vittatus* are the same. The name *vittatus* was published first, but it had earlier been used by Bigot for an insect which (as I learn from Dr. Dyar) Mr. F. W. Edwards now treats as a valid species of *Aedes*. *A. sansoni* is common in the Transition and Canadian Zones of Colorado: Boulder; S. Cottonwood Cañon near Buena Vista; two miles south of Leadville Junction; Crystal River near Red Stone (here also a small variety which looks distinct); three miles southwest of Salida; Upper Twin Lake. Prof. J. Henderson took it at 9,200 ft., southwest of Rabbit Ears, North Park, Colo., July 14, 1911, along with an *Aedes* with black tarsi and very long proboscis, not at present determined. A female which I collected at Estes Park Village, June 24, is said by Dr. Dyar to be near to or identical with *sansoni*.

(15) *Aedes stimulans* Walker. Recorded from Florissant, 1907 (Cockerell & Rohwer, on an old determination of Dr. Dyar's, when *sansoni* was not distinguished. It was presumably *sansoni*. I have, however, a very close relative of *stimulans* in a female from two miles above Minturn (P. Andrews). It is remarkable for the large palpi, and is certainly not *sansoni*. Dr. Dyar says it is new to him, but it is not described, as we have neither male nor larva.

(16) *Aedes triseriatus* Say var. *hendersoni* n. var. ♀. Dorsum of thorax anteriorly with at least lateral thirds covered with silvery scales; abdomen strongly purple, with the lateral white marks cuneiform, pointed mesad. 2 ♀. Box Elder Creek, 19 miles west of Douglas, Wyo., August 25, 1917 (Schwabe and Hen-

derson), with *A. cinereus* and *A. vexans*. Comparing this with *A. triseriatus* from New Jersey and New York, I thought it distinct, but Dr. Dyar doubts whether it is worth naming as a race. Dr. Dyar observes, however, that in Montana also the *triseriatus* has the silvery lateral areas of mesonotum enlarged, while in Texas and Maryland they are narrow (typical *triseriatus*), and in Florida they are still more reduced. That is to say, the silvery areas are most developed in the arid west, and most reduced in the humid south.

(17) *Aedes vexans* Meigen. Very common at lower levels, as along the eastern foothills and adjacent plains. Boulder, Camp Baldwin, Denver, Boone, Grand Junction, Rifle Range near Golden, Grand River 13 miles above Glenwood Springs. It is a species of the Transition Zone with us, and is not found in the high mountains. In Wyoming, it was found at Basin, Box Elder Creek, Shell Creek and near Ten Sleep, being evidently as abundant as in Colorado.

We also have a series of specimens of *Aedes* with black tarsi, which may represent two or three additional species; but as we have only females, and these mostly in bad condition, nothing definite can be said about them.

I am indebted to Mr. F. Knab for assistance, but also and especially to Dr. H. G. Dyar, who has sent me many named specimens, and has examined all my puzzling forms. Had it not been for his kind assistance and advice, I could not have ventured to write this paper at the present time.[1]

Adjournment.

SECTION ON APICULTURE

[The following is all of the proceedings received by the editor]

IMPORTANT FACTORS IN THE SPREAD AND CONTROL OF AMERICAN FOULBROOD

By E. D Ball

When the apiary inspection work of Wisconsin was recently placed in the writer's charge, a hasty survey was made of the existing situation in the state with reference to the occurrence of foulbrood and the method employed in inspection.

The situation was found to be serious and the inspection methods used totally inadequate under the conditions existing. On extending the survey to other states somewhat similar conditions were found to exist and often similar methods of inspection were in vogue.

[1] Since the above was written, Prof. C. P. Gillette has very kindly loaned the Culicid collection of the Colorado Agricultural College. This will be reported on at a later date.

From Inspector France's last biennial report we find that he visited 34 places and found foulbrood in 21 of them. If a line is drawn across the map of Wisconsin through Appleton and Eau Claire, thus separating it into northern and southern sections, it will be noted from his report that foulbrood was found in every county in which inspections were made south of that line, excepting three, and only a single place was visited in each one of these three counties. What would have been found if further inspection had been carried on can best be suggested by a glance at the maps showing the areas inspected this season.

North of the line mentioned 6 counties were visited and no foulbrood was found. This does not mean that foulbrood does not exist north of the line, as we have a number of records showing its presence in that region, but it probably indicates that there is far less of it in the northern district than in the southern.

Inspector Kindig in Bulletin 55 reports similar conditions in Michigan and the same difference between the northern and southern parts of the state. Inspector Rea of Pennsylvania in his latest publication reports conditions in that state much better than the above but notes some localities with similar conditions.

As a result of the survey of conditions it was decided that the "area clean-up" method of inspection was the only one that promised to cope with the existing situation, and so the work of the present season was organized along that line. The funds being limited, only three areas were undertaken. Two of these were chosen because active coöperation and support were assured from local associations, and the other to protect the University Experimental Apiary from contagion.

Owing to war calls and bad weather, less work was done than was planned and only parts of each area were covered. As far as the work went, however, every place where bees were kept or where they had been kept at any previous time was inspected. The old hives, frames, etc., in the honey houses or lying around outside were carefully gone over—every living colony was opened and at least four frames from the center of the brood chamber examined, even where no disease was found. Where disease was found in an apiary every frame was examined unless disease was found sooner. This method requires much work and care but the results obtained when charted and compared with previous knowledge were so strikingly different that there was no comparison—or rather that there was a very definite comparison possible.

The following table shows 161 apiaries inspected in 1917 of which 79 or one half of them had foulbrood. This is to be compared with 33

TABLE I—RESULTS OF THE SEASON'S WORK IN THE CLEANUP AREAS

Area No.	Apiaries Examined					Colonies Inspected	
	Total	American	European	Total Diseased	Free	Total	Diseased
1	67	21	24	41	26	2,327	357
2	76	28	—	28	48	1,811	317
3	18	10	—	10	8	385	78
Total	161	59	24	79	82	4,523	752

diseased apiaries found in the whole state in the previous two years of inspection service and only 7 of these in the three counties of which the three cleanup areas covered about one fourth. One fourth of 7 would be an average of 2 for the entire cleanup area but that would not be a fair basis as each cleanup was started from one of the previous cases, so this number should be doubled. But 4 diseased apiaries known where there proved to be 79 shows how really inefficient the old method was and how hopeless the expectation of ever cleaning up any bad area, such as these proved to be, by that method.

It would be foolish to say or to expect that these areas are "cleaned up"—they are not—but the actual condition is now known. Every owner knows his problem and has the knowledge necessary to success; many are already clean, others are on the watch and the reinspection will be comparatively easy in most cases. All this is, however, preliminary to the real object of the present paper.

In the inspection work one is frequently met by the statement that it is of no value to clean up foulbrood in the apiaries as long as the bee-trees cannot be inspected, as the disease will be redistributed over the area from this source. As bee-trees abound in a very large part of the honey-producing section of the state this seemed to be a problem worthy of careful consideration and investigation.

The writer was fortunate enough to be in the field while all the work was carried on in one part of area number 2, and tried to ascertain the source of each case of American foulbrood found in this district. The results were so striking and so at variance with the common belief as to the general means of spread of this disease that they have been plotted in Figure 1.

We see from the chart that the primary infection occurred along the Wisconsin River. This infection is apparently of long standing as most of the apiaries in the immediate neighborhood have been entirely destroyed for some years past. Mr. S.'s case is typical. He purchased bees from Mr. A. many years ago. From 112 swarms at one time his apiary dwindled down until not a single swarm was left alive. Mr. S. lives beside the only bridge across the river for many miles

and a sign on this bridge offering for sale the hives, frames and comb distributed this material over a wide area on both sides of the river. Not all of this area has been worked over but every infection with the exception of one (the origin of which is not known) in the region tribu-

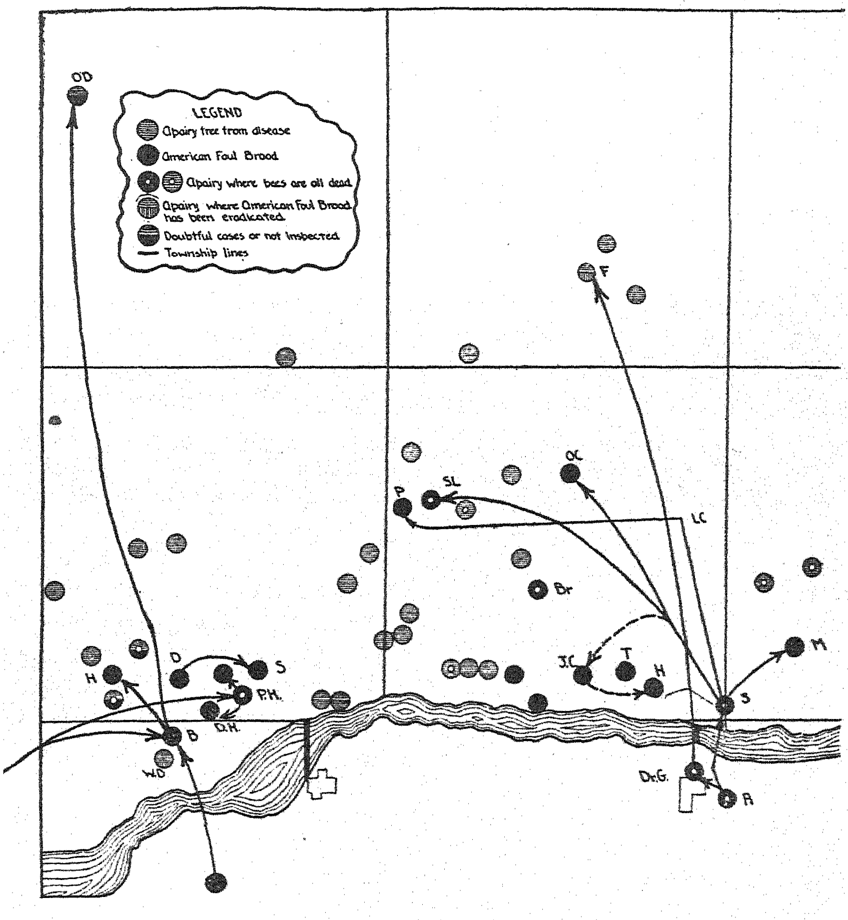


Fig. 9. A part of Area No. 2 showing the method of distribution of American foulbrood in this region.

tary to this bridge can be traced directly or indirectly back to this spot and to this method of distribution.

Two apiaries within a mile of each other are particularly illuminating in this respect. Mr. Sl. purchased a few empty hives from Mr. S. a number of years ago and placed them in a then prosperous apiary. Three years ago the last swarm of the apiary died and the entire out-

fit is now stored in a honey house. Mr. P., within a mile of this apiary on the same ridge, with bees covering the same pasturage, developed a prosperous apiary along side of this, apparently without infection until two years ago when the two remaining swarms of an apiary at some distance (L.C.) were purchased. This apiary had previously bought material from the original source at the bridge. When examined this year these two swarms were badly diseased and everything else in the apiary appeared to be recently infected. Mr. F., owner of a prosperous apiary in another section, bought two swarms from across the river and later discovered that they had foulbrood. He then destroyed them. Still later he found five or six more cases in his yards and destroyed these. His apiaries are now entirely free from disease as is the community.

Just below the next bridge is another badly infected area. Here the origin is somewhat obscure as there may have been two sources. Mr. B. and Mr. P.H. bought bees from another section further down the river several years ago. Mr. B. later bought a single hive from across the river. Soon after the first purchase their bees began to dwindle until Mr. P.H. lost every colony in the apiary where these bees were placed, while Mr. B. had only two left in his.

Five other apiaries in this section were found infected. Mr. B. sold to Mr. O.D., 12 miles distant, who has not been inspected as yet.

Of these five infections three are traceable directly to the two primary ones. Mr. G.'s case is instructive—he bought a few hives from his relative, Mr. D., and they were found badly infected as were Mr. D.'s, while the remainder of Mr. G.'s apiary was only just beginning to show the disease. Yet Mr. G.'s bees had been within a mile of Mr. P.H.'s during the time they died out while Mr. W.D.'s bees were even closer to Mr. B. and remained free from disease.

Out of 20 cases of American foulbrood in this area 15 are apparently definitely known to have been transmitted by the movement of hives and comb, while of the other 5 little information is available. In a number of cases the owners are related and would give little information in regard to possible sources, trying to magnify the importance of the bee-trees and minimize other possible sources. This investigation will be extended to the limits of this area and continued in other areas where the disease exists as they are surveyed, but if the findings of this area are borne out in other situations it will indicate that the most important method of preventing the spread of this disease is a strict quarantine of all infected material and the wide and persistent publicity of the fact that second-hand supplies should never be purchased except from recently inspected premises. Along with this should of course go the cleaning up and eradication of the disease in these areas,

but that work can go on with much more hope and encouragement if the "bogy" of the diseased bee-tree and the wide transmission of this disease by infected honey can be first eliminated from the minds of the people in country districts and in their place substituted a hope and expectation of freedom from the disease as a result of the "area clean-up" method of treatment.

[Papers read by Title]

AN EMERGENCE RESPONSE OF TRICHOGRAMMA MINUTUM RILEY TO LIGHT[1]

By George N. Wolcott

While temporarily employed by the U. S. Bureau of Entomology from June to August, 1917, to work on sugar-cane insects in the Rio Grande Valley, Texas, the writer collected large numbers of egg clusters of the sugar-cane moth stalk borer, *Diatræa saccharalis* Fabr. After trying various localities in the valley where sugar-cane was grown, Harlingen, Texas, was selected for continuous work, as in two fields there about a mile north of the railroad station, *Diatræa* was very abundant. In all, 1,506 clusters were collected from these two fields, and of these 944, or 62.6 per cent, were parasitized by the hymenopteron, *Trichogramma minutum.*

The individual *Diatræa* egg is oval and flattened, lenticular in cross-section, and these plate-like eggs are deposited in single, double or triple (or irregularly four, five, and sometimes even six) rows, overlapping like shingles or slates on a roof. The following table gives the number of eggs in the masses, and the frequency with which different numbers occurred:

Number	*Frequency*	*Number*	*Frequency*	*Number*	*Frequency*
3	2	18	66	33	19
4	1	19	76	34	14
5	1	20	50	35	16
6	7	21	56	36	11
7	19	22	55	37	10
8	20	23	53	38	11
9	35	24	44	39	5
10	38	25	40	40	5
11	47	26	30	41	11
12	48	27	36	42	4
13	50	28	27	43	6
14	49	29	17	44	2
15	64	30	21	45	6
16	63	31	11	46	5
17	66	32	27	47	7

[1] Published by permission of the Chief of the Bureau of Entomology.

Number	*Frequency*	*Number*	*Frequency*	*Number*	*Frequency*
48	3	53	2	60	1
49	2	54	1	67	1
50	1	55	1	68	2
51	2	56	1	70	1
52	3	59	2	71	1

The eggs are creamy white when first laid, becoming yellower in a few hours, orange in a couple of days, and when nearly ready to hatch the dark brown head of the young caterpillar can be seen through the transparent shell. The clusters parasitized by *Trichogramma* become black soon after parasitization, and after the emergence of the parasite the eggs are still black because of the black débris remaining; while of the unparasitized eggs only a whitish egg shell is left when the caterpillar hatches out. It is thus possible to tell definitely, except when freshly parasitized, which clusters and which eggs in the cluster are parasitized. Of 380 clusters on which data are available, 65.3 per cent were totally parasitized and 34.7 per cent only partly parasitized, 20 per cent of the eggs in these clusters being not parasitized.

The egg-masses are impartially deposited on either the upper or lower side of the cane leaves. They may be on the midrib or on any other part of the leaf, even to the edge, but usually they occur from the center to the tip, rather than closer to the stem of the plant. In collecting *Diatræa* egg clusters a portion of the leaf surrounding the egg-mass was broken off and placed in a tin box. All collections were made between the hours of 7 a. m. and 10 a. m. In the afternoon the bits of leaves bearing the egg-masses were removed from the tin boxes one by one and trimmed so as to go easily into a 7 mm. x 25 mm. vial. Corks were used to close the vials after they had been allowed to dry out for half an hour or more, and a wad of absorbent cotton was packed down in the bottom of the vial on the opposite side of the piece of leaf from that bearing the eggs. In this way the moisture exuded and transpired was largely eliminated and the piece of leaf was held securely in place. Unless the cotton was tightly packed in, however, the emerging caterpillars, and especially the adult *Trichogramma*, became inextricably entangled in the loose fibres. Both young *Diatræa* caterpillars and adult *Trichogramma* are positively phototropic to a very marked degree, and when the bottom of the vial was towards the window, they would push into even the most tightly wadded piece of cotton in their efforts to reach the source of light. When the vials have the corks towards the window, some of the *Trichogramma* manage to get between the cork and the edge of the vial, and are often crushed when the cork is removed, while the young *Diatræa* caterpillars will bore into the dry cork, often making a tunnel several times their own length. To obviate the difficulties connected with the phototropic

reactions of the emerging insects, the vials were kept in the dark and only exposed to light for a short time each day, when observations on emergence were made.

Upon removing the vials from the dark the great majority would show no *Trichogramma* adults emerged, but as one continued looking over them, *Trichogramma* would begin to appear in vials in which none had been visible when first examined. Some of the tiny insects would have their wings not yet expanded, and others would show only one red eye or the entire head looking out from the hole in the egg shell, but in five or ten minutes the vial would be full of the active little wasps. To determine just how definite was this emergence response of *Trichogramma* adults to light, a large number of observations were made at various times of day.

The method of procedure was to remove the vials from a large card-board mailing tube, with a screw top tin cover, one by one. The emerged *Trichogramma* adults were counted as they left the vial when the cork was removed and the open end turned towards the light. These vials were placed in order in front of the window, while the vials containing egg clusters from which no adults had emerged were also placed in regular order in the same situation, but in a separate row. At the end of an hour the vials were again examined, *Trichogramma* adults counted as they left the vials, and the vials returned to

Material Collected August 1		
Vial No.	Emerged between 6 p.m. Aug. 3 and 9 a.m. Aug. 4	Emerged between 9 a.m. and 10 a.m. Aug. 4
	Dark	Light
1	3	14
2	4	11
3	2	12
4	4	5
5	1	23
6	4	11
7	7	11
8	3	25
9	33	0
10	0	22
11	0	8
12	0	1
13	0	27
14	0	31
15	0	1
16	0	27
17	0	4
18	0	17
19	0	7
20	0	4
	61	258

61 emerged in Dark
253 emerged in 1 hour Light
Ratio 4.23

Material Collected July 30			
Vial No.	Emerged between 7 p.m. July 30 and 1.05 p.m. July 31	Emerged between 1.05 p.m. and 2.05 p.m. July 31	
	Dark	Light	
		1.10 p.m.	
1	10	0	10
2	6	0	16
3	12	0	3
4	5	0	12
5	9	0	19
6	0	5	20
7	0	5	12
8	0	5	7
9	0	0	8
	42	15	102+15

42 emerged in Dark
15 emerged in 5 minutes Light
117 emerged in 1 hour Light
Ratio 2.78

the dark mailing tube. The ratio of the total number of adults which had emerged before exposure to light as compared with the total number which emerged after exposure to light, either from egg clusters from which no adults had previously emerged or from which some adults had already emerged, expresses what has been assumed to be the emergence response to light. A few examples of individual daily observations are given.

In the following table, all the observations, summarized, are given.

RATIOS OF EMERGENCE RESPONSE OF TRICHOGRAMMA TO LIGHT

Days after Collection	7 a. m.	9 a. m.	10 a. m.	11 a. m.	12 m.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	6 p. m.	Average
1	25.33	.66 2.12	2.69	1.08	1.27	2 2.78	2.17	....	.47	.2	3.7
2	....	2.28	3.38	.67	....	1.51 .65 .93	.73	.71	1.22	....	1.34
3	5.11	4.23	1.71	....	.25	1.26	....	....	.42	.12	1.87
4	....	....	....	.35	.36	.4	.25	.81	....	....	.55
5	....	1.55	....	....	....	....	.21	....	....	....	.88
6	....	....	....	....	....	....	.35	....	....	.5	.42
Average	15.22	2.17	2.59	.9	.63	1.36	.74	.76	.7	.27	....

The number of hours between the observations on succeeding days bore no constant relation to the emergence response, and is not indicated. It is obvious that the emergence response is not as strong several days after collection. This may be due to unnatural conditions of moisture, curling of the bit of cane leaf, or fungus growing on it, but it may also be a result of the lessened chance of an organism responding to light when it has experienced only one twelfth (±) as much as it normally would receive. There was no way to differentiate between the egg clusters from which *Trichogramma* would emerge in a few hours and those in which several days were necessary for development, and both consequently received the same treatment. Thus the adults emerging in four or five days received ordinary room light for only four or five hours plus the light before collection, while those emerging the next day after collection had been exposed to bright sunlight twelve or more hours a day, except for a short period just prior to emergence.

It is also to be noted that the emergence response of *Trichogramma* is not as strong in the late morning, or afternoon, as earlier in the day. This is to be expected. In the field, *Trichogramma* adults just emerged from the eggs have been observed at the following times: 7.15 a. m. (July 24), 8.15 a. m. (July 27), 8.05 a. m. (August 1), 7.45 a. m. and 8.10 a. m. (August 7), 7.15 a. m. (August 9), 8.45 a. m. (August 13), 8.15 a. m. (August 14). The average of these times is 8.06 a. m. Adults have not been seen at other times, although obser-

vations have been made at all times of day. The normal time of emergence is thus approximately two hours after sunrise, but if sunrise —as far as the eggs are concerned—is artificially delayed by keeping them in the dark, emergence will also be delayed. To just how great an extent, and how lack of light fails to prevent emergence late in the day, the summarized data in the foregoing table has shown. But this is hardly a fair comparison, and in the following table the ratios represent the adults emerging in the first hour of exposure to light as compared with the adults emerging in the dark, per hour of previous daylight in the same day, or rather after 7 a. m.—which is apparently as early as daylight is effective.

Days after Collection	7 a. m.	9 a. m.	10 a. m.	11 a. m.	12 m.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	6 p. m.	Average
1	25.33	{4.25 1.33	8.08	4.31	6.36	{12. 16.71	15.22	....	4.24	2.26	9.09
2	....	4.56	10.08	2.4	....	{9.– 4.– 5.44	5.1–	5.62	10.97	....	6.35
3	5.11	8.46	5.–	....	1.42	....	....	....	3.77	....	4.75
4	....	....	....	3.78	1.8–	7.65	1.76	6.54	....	....	4.3
5	....	3.1–	....	....	....	2.42	1.48	....	....	....	2.33
6	....	....	....	....	....	....	2.	....	....	5.5	3.75
Average	15.22	4.34	7.71	3.5–	3.2–	8.17	5.11	6.08	6.32	3.88	....

The average of 35 experiments indicates that six (6.19) times as many adults of *Trichogramma minutum* emerge in the first hour after being exposed to daylight, as emerge in the dark per hour of previous daylight in the same day.

NOTES ON SOME SOUTHWESTERN BUPRESTIDÆ[1]

By H. E. Burke, *Specialist* in Forest Entomology, Bureau of Entomology, U. S. Department of Agriculture

The following paper gives the host plants and some biological notes on eighteen species of flathead borers (*Buprestid* larvæ) mostly from Sabino Canyon, Santa Catalina Mts., Arizona. Larvæ and sections of infested wood were collected in the field and shipped to the Forest Insect Laboratory, Los Gatos, Calif., where the adults were reared. Practically all of the collections were made by Specialist W. D. Edmonston and Entomological Rangers George Hofer and Morris Chrisman.

The names given are taken from Henshaw's "List of the Coleoptera of America, North of Mexico" and are those commonly used. The writer is responsible for the identification of the larvæ and Mr. W. S.

[1] Published by permisson of the Secretary of Agriculture.

Fisher of the Branch of Forest Insect Investigations for practically all of the adults.

Several of the species are of considerable economic importance because their winding larval mines riddle the wood of the mesquite and other southwestern shrubs and trees. Posts and piles of mesquite firewood are sometimes severely damaged by the work of *Chrysobothris octocola* and closely related species.

A few of the species such as *Melanophila pini-edulis* will kill trees or parts of trees but the majority of them are secondary and attack the tree only after it starts to die or is already dead.

Psiloptera sp. possibly webbi Lec.—Specimens from Arizona; mines wood of old dead trees; palo verde (*Cercidium torreyanum*); one larva found in the heartwood of an old dead tree in Sabino Canyon.

Melanophila pini-edulis Burke.—Colorado, Utah, Arizona; mines bark and outer wood of the limbs and trunk of dying, dead and living trees of the pinion (*Pinus edulis*); in the laboratory emerges during June, July and August; assists Scolytids and Cerambycids to kill trees.

Chrysobothris octocola Lec.—Arizona, Texas; mines bark and wood of injured, dying and dead shrubs and trees; mesquite (*Prosopis juliflora*) and palo verde (*Cercidium torreyanum*); in the laboratory emerges from the wood in August and September; the larval mines riddle the wood and often cause severe injury to mesquite posts and firewood.

Chrysobothris edwardsii Horn.—Arizona; mines bark and wood of dying and dead stems; ocotillo (*Fouquieria splendens*); in the laboratory emerges in August and September.

Chrysobothris debilis Lec.—Arizona; mines bark and wood of dying and dead limbs and trunks of shrubs and trees; live black oak (*Quercus emoryi*), palo blanco hackberry (*Celtis reticulata*), cats claw (*Acacia greggii*), mesquite (*Prosopis juliflora*) and palo verde (*Cercidium torreyanum*); in the laboratory emerges from May to October.

Chrysobothris axillaris Horn.—Arizona; mines bark and sapwood of dying and dead limbs of live black oak (*Quercus emoryi*); in the laboratory emerges in July.

Chrysobothris ignicollis Horn.—Colorado, Arizona; mines bark and sapwood of dying and dead limbs of living trees and also dying and dead trees; Rocky Mountain juniper (*Juniperus scopulorum*) and probably alligator juniper (*Juniperus pachyphlœa*); flies in July.

Chrysobothris ludificata Horn.—Arizona; mines bark and sapwood of dying and dead limbs, logs and stumps; western yellow pine (*Pinus ponderosa*); according to Mr. A. J. Jaenicke of the Forest Service this is the common species on yellow pine slash in northern Arizona; flies in June.

Chrysobothris trinervia Kirby.—South Dakota, Colorado; mines bark and sapwood of dying and dead limbs and trees: limber pine (*Pinus flexilis*) and western yellow pine (*Pinus ponderosa*); according to Mr. B. T. Harvey this species kills young yellow pine saplings in the Black Hills of South Dakota by girdling them close to the ground; in the laboratory emerges in June, in the field flies in August.

Chrysobothris breviloba Fall.—Colorado; mines bark and sapwood of dying and dead trees; western yellow pine (*Pinus ponderosa*); according to Mr. B. T. Harvey this species lays its eggs between the scales of the bark; flies in July and August.

Chrysobothris exesa Lec.—Arizona; mines bark, sapwood and heartwood of dying and dead trees; mesquite (*Prosopis juliflora*); young beetles found in the heartwood of dead trees in February and March; in the laboratory emerges in June.

Chrysobothris texana Lec.—Colorado; mines bark and wood of dying and dead trees; Mountain juniper (*Juniperus scopulorum*).

Chrysobothris gemmata Lec.—Arizona; mines bark, sapwood and heartwood of dying and dead limbs and trunks; mesquite (*Prosopis juliflora*); present observations indicate that this species may kill branches and entire trees; the work causes severe injury to the wood.

Chrysobothris merkelii Horn.—Arizona; mines bark, sapwood and heartwood of dying and dead stumps, limbs and trees; cats claw (*Acacia greggii*) and mesquite (*Prosopis juliflora*); may kill trees; young beetles taken from the wood in February.

Actenodes calcarata Chev.—Arizona; mines sapwood and heartwood of dying and dead trees; palo verde (*Cercidium torreyanum*) and probably bacchata (*Zizyphus obtusifolia*).

Acmæodera conoidea Fall.—Arizona; mines dead flower stalks of the sotol (*Dasylirion wheeleri*); in the laboratory emerges in August and September.

Acmæodera larreæ Fall.—Arizona; mines heartwood of dying and dead stems of the creosote bush (*Covillea tridentata*); adults taken from the wood in January.

Tyndaris olneyæ Skinner.—Arizona; mines sapwood and heart wood of dead limbs; cats claw (*Acacia greggii*), mesquite (*Prosopis juliflora*) and palo verde (*Cercidium torreyanum*).

NOTES ON FALSE WIREWORMS WITH ESPECIAL REFERENCE TO ELEODES TRICOSTATA SAY[1]

By James W. McColloch, *Assistant Entomologist*, Kansas State Agricultural Experiment Station

With the establishment, in 1915, by the Department of Entomology, of project No. 100, dealing with a study of those insects injuring the roots and germinating seeds of staple crops, the writer undertook a study of the available species of the tenebrionid genus *Eleodes*.

There are two primary reasons why this group of insects was chosen as a part of this project. First, practically nothing is known concerning the life-histories of the various members of this genus. Swenk (1909) partially worked out the life-history of *E. opaca* Say, and Hyslop (1912) gives a short synopsis of the life-history of *E. letcheri vandykei* Blaisd. According to Gebien (1911, pp. 242–252), the genus is a large one, containing 123 species. Eleven of these species have been recorded from Kansas. Second, the beetles of the genus *Eleodes* are native insects confined principally to the semi-arid regions west of the Mississippi River. In fact, only three species, *tricostata*, *opaca*, and *suturalis* (Wickham, 1899) have been recorded east of Kansas. In Kansas, they are typical of the native prairies and farther west they are found in the sage brush areas. The gradual breaking out of these prairies is depriving these insects of their native food and is forcing them to feed on the more succulent cultivated crops. Just how successful the different species are in becoming adapted to the new conditions is an interesting problem. *E. opaca* has already become a serious pest of wheat in Kansas and Nebraska. *E. letcheri vandykei* has appeared in cultivated fields in the Pacific Northwest, and, in 1913, *E. extricata* var. *convexicollis* Blaisd. was found attacking grains in Montana.

The life-histories of several species have now been studied at the Kansas Experiment Station and that of *E. tricostata* will form the basis of this paper. Reference will be made to other members of the genus, especially when they touch on the species under consideration.

Economic Importance of the Genus

It is only within recent years that the false wireworms have been recognized as pests of growing crops. Blaisdell (1909, p. 29) states

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 32. This paper embodies some of the results obtained in the prosecution of project No. 100 of the Kansas Experiment Station.

that as far as he has been able to determine, species of this genus are neither injurious nor beneficial, unless the larvæ are in some way troublesome. Riley (1884, p. 90) records the adult of *E. quadricollis* Esch. injuring the foliage of grapes in California. This species is said to have destroyed 35 acres of grape vines. Bruner (1892, p. 12) found *E. tricostata* injuring cabbages and other garden crops at Lincoln, Nebraska. Swenk (1909, pp. 332–333) gives an account of the serious damage done to planted grain, especially wheat, by *E. opaca* in western Nebraska. Hyslop (1912, p. 75) states that the results of three years' work demonstrate quite conclusively that the false wireworms are among the most destructive insects to recently planted wheat and corn in the Pacific Northwest. *E. pimeloides* Mann. and *E. letcheri vandykei* are discussed especially in this regard. Webster (1912, p. 32) reports *E. sulcipennis* Mann. feeding on the larvæ of alfalfa weevil and *E. suturalis* Say eating chinch bugs. Essig (1915, pp. 290–291) records the adult of *E. omissa borealis* Blaisd. as feeding on the leaves of apricot, orange, plum, and watermelon. Cooley (1916, p. 154) has found *E. extricata* var. *convexicollis* Blaisd. very abundant in Montana and in several instances seriously injuring newly sprouted grain.

The above references comprise most of the known reports of the injuries by this genus. That more is not known concerning them is probably due to a number of factors. The larvæ closely resemble the true wireworms and considerable confusion has resulted. Much injury attributed to wireworms, especially in the semi-arid regions, is probably due to the false wireworms. The larvæ are subterranean in their habits and move with great rapidity through the soil, hence it is often impossible to find them at work. The adults are largely nocturnal in their habits, and although they may be extremely numerous in a locality, they are seldom found without a diligent search.

Economic Importance of Eleodes tricostata

The data on the economic importance of *E. tricostata* are very meager. Wickham (1890, p. 86) states that it feeds on the roots of grasses, and Bruner (1892, p. 12) found it seriously injuring cabbages and other garden crops at Lincoln, Nebraska, and states that it was doing more damage than cutworms. He also says that it is a general feeder upon the prairies and on weeds in the field. Hunter, Pratt, and Mitchell (1912, p. 51) list *E. tricostata* among the insects incidentally associated with the cactus plant.

In Kansas, *tricostata* appears to be confined almost entirely to the native pastures where the larvæ feed on the roots of the various grasses occurring there. Practically all the adults and larvæ collected in the

field have been taken in such situations. A few larvæ and adults have been found in wheat and corn fields, but the data thus far collected indicate that this species is a pest of our native prairie grasses. In the laboratory, however, the adults and larvæ feed readily on germinating wheat and corn and there seems to be no reason why this should not occur in nature. The adults also feed freely on young wheat plants growing in the cages.

Distribution

E. tricostata is one of the more widely distributed species of this genus. Blaisdell (1909, pp. 38 and 107–108) records it from Texas, New Mexico, Oklahoma, Utah, Kansas, Nebraska, Iowa, Idaho, Montana, Colorado, Wyoming, South Dakota, and British America. Say (1823, p. 262) gives the type locality as Missouri and Arkansas. Wickham (1899, p. 60) says it extends as far east as Independence, Iowa, where he found it in September on a broad, dry sand-flat along the Wapsipinicon bottom. Stoner (1913, p. 81) records taking *E. tricostata* at Fergus Falls, Minnesota, in 1911. This is the first known record of a species of *Eleodes* being taken in that state. In Kansas, this species is distributed over most of the state. Popenoe (1877, p. 36) says that it is common throughout the state and the collection of the Department of Entomology contains specimens from all regions of Kansas except the southeastern part.

Methods of Rearing

In carrying out the life-history study, the writer found the following methods successful in rearing each of the different stages. Eggs were placed in small vials closed with cotton plugs and kept in the field insectary under outdoor conditions. The larvæ on hatching were placed in one-ounce tin boxes containing slightly moistened soil and a small amount of bran for food. As the larvæ became larger, they were supplied with germinating wheat instead of bran for food. During the summer, it was necessary to change the soil in these boxes about every ten days, but in winter when the larvæ were rather inactive, it was changed about every three weeks. The pupæ were kept in the same boxes in which the transformation took place. The adult beetles were confined in pint fruit jars, containing about an inch of dry soil and a little bran.

With the exception of the eggs, all stages were kept in the cement cave previously described by the writer (1917) where the temperature more nearly approximated subterranean conditions. During the summer months, the temperature of the cave varied from 70° to 80° F. With the approach of cold weather, the temperature gradually fell

until early in March when it was about 40° F., after which time it began to rise slowly. The results obtained in the life-history work in the cave coincided closely with the field observations made throughout the year.

Description and Life Economy

The Egg.—The eggs (Pl. 5, A) of *E. tricostata* are bluntly oval longitudinally, and circular in diameter. They vary in length from 2.2 mm. to 2.5 mm. and are about 1.2 mm. in diameter. The eggs of this species are much larger than any so far described for the genus. Blaisdell (1909, p. 496) states that the eggs of all species of *Eleodes* which he has examined are about 1 mm. in length. The freshly laid eggs are white in color with no surface markings. As development takes place the color changes to a light creamy yellow.

When deposited, the eggs are coated with a sticky solution which causes a thin layer of dirt to adhere to them, making them hard to find in the field. They are laid singly, although several may be placed in the same cavity. In the rearing cages, the females seemed to prefer dry dirt for oviposition as practically all of the eggs were found in the driest dirt. In oviposition, the female excavates a cavity one-fourth inch to three inches in depth and deposits from one to four eggs, after which she fills the hole with dirt.

In hatching, the young larva splits the egg shell at the end and down the side about one-third the way. The larva usually emerges head first but it is not unusual for the reverse to occur. The egg shell appears to be broken by the larva arching the body and this may cause the shell to break at either the anterior or posterior end. When the larva emerges head first, the process requires a very short time, but when it emerges with the posterior end first, several hours may be consumed in emerging, and, in some cases, the larva may be unable to free the head from the shell.

The length of egg stage was determined for 300 eggs in 1915 and 4,800 eggs in 1916. The following table gives the essential data:

Incubation Period

Date	No. Eggs Hatching	Min. Days	Max. Days	Average Days
1915	300	10	30	14.5
1916	4800	6	46	14.0

The length of the egg stage varies with the season of the year. Eggs laid during July and the first half of August hatched in from 6 to 11 days. After the middle of August the length of the egg stage increased

rapidly until November when it was about 46 days. In 1916, the first eggs were deposited on July 10 and the first ones hatched on July 16. The last eggs were laid October 12 and the last egg hatched November 20. This gives a period of 133 days that eggs were to be found.

THE LARVA.—Very little has been written concerning the larvæ of *Eleodes*. Gissler (1878, p. 19) gives a meager description of the larvæ of *E. gigantea* Mann. and *E. dentipes* Esch. Blaisdell (1909, pp. 497–499) enlarged on the description of *dentipes* and gives a working basis for the description of the various larvæ of the genus. Hyslop (1912, pp. 78–81) describes the larvæ of *E. letcheri vandykei* and *E. pimeloides*. In many ways the false wireworms resemble the true wireworms but may be readily distinguished from them by the fact that the antennæ of the *Eleodes* larva are clavate and longer. The false wireworms also show a much greater activity than do the true wireworms.

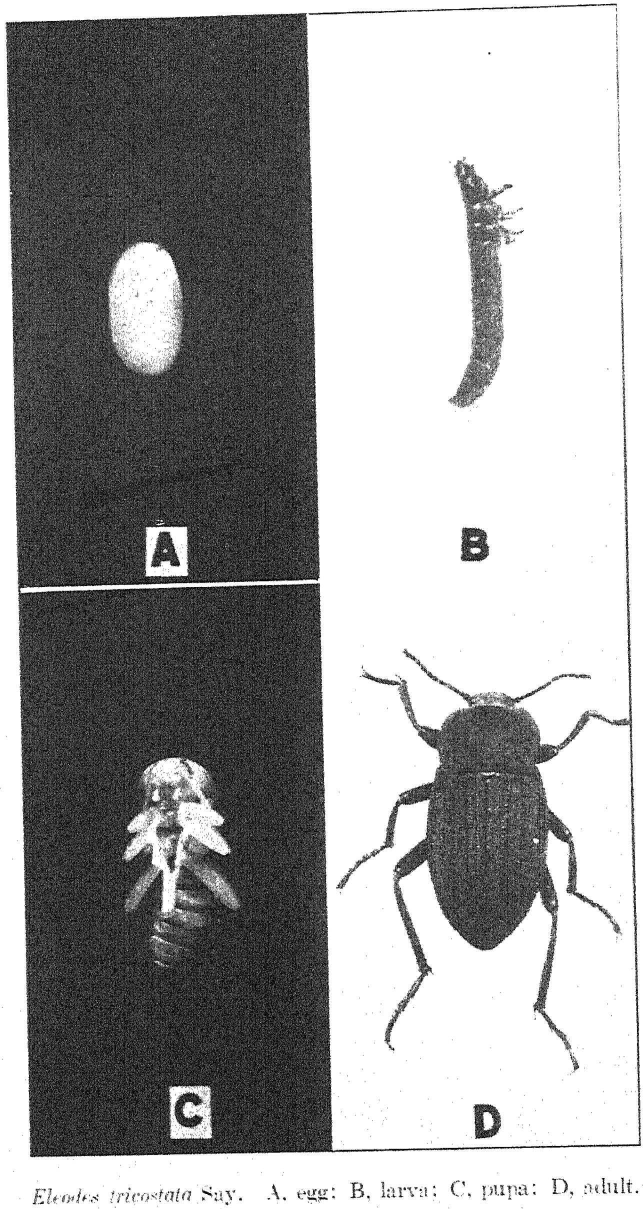
On hatching, the larva (Pl. 5, B) of *E. tricostata* is 3.75–4 mm. in length and creamy white in color. After the first moult, the larva changes to black in color and this color persists, except immediately after moulting, during the rest of this stage. In this respect, it differs from any of the described *Eleodes* larvæ. When full grown, the larva is about 35 mm. in length.

The larvæ are subterranean in their habits, being found during the summer and fall from one to six inches or more below the surface of the ground. It is not uncommon to find them under stones on grass-land but so far the writer has never observed them on the surface of the ground. They burrow from place to place, feeding on the roots and seeds of plants and probably, to some extent, on decaying organic matter. In the vicinity of Manhattan, the larvæ appear to be confined to the native grass-land and practically all larvæ found have been taken in such situations. In confinement, however, they feed readily on germinating wheat and corn, on bran, roots of grasses, and, to some extent, on manure. In addition to this, they often feed on their cast-off skins and on larvæ that have died or are in a weakened condition.

The length of the larval stage was determined for 111 larvæ in 1915 and 1916, these data being summarized in the following table:

LENGTH OF LARVAL STAGE

Year	No. of Larvæ	Min. Days	Max. Days	Average Days
1915–1916	51	252	291	267
1916–1917	60	68	332	292



Eleodes tricostata Say. A, egg; B, larva; C, pupa; D, adult.

Most of the worms reached the next to the last moult during the summer and fall and passed the winter in this condition. From the first of November to the first of March they fed but little and were very inactive. Commencing the first week in March, they began feeding again and moulted during April or May. The first larva pupated May 27 and the last larva on June 30. Field data bear out this study. Practically full-grown larvæ were found in the grass-land during early April. These moulted and pupated about the same time as those reared. It is interesting to note that five larvæ, hatching from eggs laid early in July, 1916, pupated during October and November. The average length of the larval stage in this case was 77 days. Before pupation, the larvæ enter a semi-pupal or quiescent stage, which lasts from five to ten days. During this time they do not feed and are very inactive.

In rearing the larvæ, it was found that they made their best growth when placed in boxes containing soil with bran and wheat for food. When fed on decaying matter and roots they made a much slower growth and in nearly every case failed to reach maturity. About 200 larvæ were reared in boxes containing nothing but dry bran. Most of these lived from three to six months but they made very little growth and moulted only once.

THE PUPA.—The pupæ (Pl. 5, C) are white in color after transformation and are 15–19 mm. in length. As development proceeds, the body color changes to creamy yellow and the mandibles, legs, and antennæ become dark in color. At the end of 14 to 16 days the mandibles and claws show a deep reddish-brown color.

Pupation took place in the spring of 1916 during the last week in May and the entire month of June. The first larva pupated on May 27 and the last one pupated June 30. Maximum pupation occurred on June 4. The pertinent data on the length of the pupal stage are shown in the following table:

LENGTH OF PUPAL STATE

Year	No. of Pupæ	Min. Days	Max. Days	Average Days
1916	49	11	22	19.4
1917	32	13	45	17.0

In one case, a larva pupated October 14, 1916, and the adult issued November 28, giving a pupal stage of 45 days. Another individual pupated October 23, 1916, and passed the winter in this stage, dying in April, 1916.

THE ADULT.—The adult beetles (Pl. 5, D) are oblong oval, black,

and clothed with short setiform hairs, each arising from a puncture. Each elytra bears three distinct costæ which are more or less coarsely muricate. The female is robustly oblong, the elytra usually being widest at the middle. A tuft of ordinary piceous spinules occurs on the tip of the first joint of the anterior tarsus; the second joint is unmodified. The male differs from the female in that the body is more oval in shape, the elytra usually being widest at the base. There is a slight modification of the first two segments of the anterior tarsus. The males are 13–20 mm. in length and about 6.5–10.5 mm. in width, while the females are somewhat larger in size, being 14–22 mm. in length and 7–11 mm. in width.

In the life-history studies, adults emerged from the pupal stage June 16 and continued to emerge until July 10, the maximum emergence occurring about June 24. Field studies coincide very closely with these results. During the early part of June, it was almost impossible to find adults in the field. Beginning about June 20, however, adults became numerous and most of them were of a bright color and the body soft, showing that emergence had just taken place.

E. tricostata may pass the winter as an adult as well as in the larval stage. During March and April of 1916, several adults were found hibernating in spherical cells under rocks. The mortality, however, is very high, varying from 50 to 95 per cent. The writer has never been able to obtain eggs from these overwintering beetles.

While most of the adults emerged before June 24, mating was not observed until July 7, when it became general in many of the cages and continued until the middle of September. The first eggs were deposited July 10, three days after copulation was noted. Egg laying continued until October 12, at which time the beetles became inactive and appeared to have entered hibernation.

Thirty-one mated females, confined in cages containing about one inch of soil, deposited a total of 5,464 eggs or an average of 176 eggs per female, with extremes of 103 and 262. The largest number of eggs deposited by a single female during a period of 24 hours was 51. The average period of oviposition for this experiment was 48.8 days, the longest being 75 days and the shortest 24 days. An average of 3.7 eggs were laid on each day. The average number of days on which eggs were laid by each female was 23.6, with extremes of 11 and 37 days. The average number of eggs laid was 8.

The proportion of sexes was determined for 1,257 beetles collected in the field during the summers of 1916 and 1917 and the males seemed to predominate, since only 551 of the beetles collected were females while 706 were males. Approximately the same proportion of sexes has prevailed in the rearing work.

The habits of the beetles have been studied to a limited extent in the field. All of the *Eleodes* are more or less nocturnal or crepuscular and *tricostata* is no exception. They may be found abroad early in the morning and towards evening or on cloudy days. During the daytime, however, they are generally found under rocks, boards, logs and manure where they are rather inactive. Once the cover is removed, however, they run with great rapidity. Feeding, mating, and egg laying take place generally at night, both in the field and in the rearing cages.

The adults have been found feeding in the field on *Solidago*, *Euphorbia marginata*, prairie clover, and evening primrose. In the laboratory, they fed on bran and soaked wheat in preference to any other food supplied. They also fed readily on growing wheat plants, especially when the plants were only a few inches high. Some of the beetles fed sparingly on roots and leaves of grasses and on decaying organic matter. They are also cannibalistic to some extent, feeding on dead beetles or those in a weakened condition.

The beetles of *E. tricostata* live for a long period. One female collected early in July, 1915, lived until May, 1916, while many beetles maturing in June, 1916, lived until June and July, 1917. The longest period thus far recorded is for a female that lived 391 days. There seems to be a tendency for the females to live longer than the males. Blaisdell (1909, p. 29) records keeping adults of *E. dentipes* alive for over four years.

Length of Life-Cycle

The length of the life-cycle normally occupies about one year. Taking the average length of the various stages, it required 328 days from the time the eggs were laid until the adults emerged. In the same way, using the minimum length of each stage, the life-cycle was 85 days, and taking the maximum length of each stage, the life-cycle was 423 days.

Predaceous Enemies

The members of the genus *Eleodes* are not preyed upon by a large number of predaceous enemies. This is probably due to the fact that the adults of most of the species secrete an oily liquid having a strong offensive odor. This is thought to be a protective secretion as it is excreted only when the beetles are disturbed. Gissler (1879) describes the glands which produce this fluid and states that they are found in both sexes. Williston (1884, p. 169) says that *E. tricostata* seems to be devoid of these secretions.

Blaisdell (1909, p. 29) says that skunks will feed on *Eleodes* and that chickens devour them readily as do the ground owls. The butcher

birds impale them on thorns. Hyslop (1912, p. 84) states that the records of the Bureau of Biological Survey list thirteen species of birds as feeding on the adults of *Eleodes*. Barrows and Schwarz (1895, p. 64) found *Eleodes* in the stomach of crows in Kansas and Nebraska, and they state that these beetles fulfil most of the requirements of insect food preferred by the crows. Judd (1898, p. 25) records the loggerhead strike as feeding on *E. tricostata* and Beal (1900, p. 70, and 1911, p. 40) has found specimens of this species in the stomachs of the crow blackbird and the red-headed woodpecker.

Parasites

Very few parasites have been found attacking any of the *Eleodes*. Bruner (1892, p. 12) records eggs of a tachinid on the elytra of *tricostata* and *opaca*. Riley (1892, pp. 211 and 219) records a braconid parasite, *Perilitus* sp., from *E. suturalis*. Hyslop (1912, p. 35) found a nematode worm infesting the abdomen of a beetle. He states that the worm nearly filled the abdomen. Ellis (1913, pp. 282–283) describes a gregarine (*Stylocephalus giganteus*) obtained from *E. hispilabris* Say and *Eleodes* sp. During the past summer, the writer found this same gregarine in the alimentary tract of *tricostata* and *opaca*. Aldrich (1915, p. 245) reports a *Sarcophaga* larvipositing on *E. tricostata*, *E. hispilabris*, and *E. obsoleta* Say.

On August 7, 1916, a number of hymenopterous larvæ were found in one of the *tricostata* cages. On examining the beetles, they were found to be coming out of the anal slit of a male. Shortly after emerging they spun silken cocoons around the edge of the cage and pupated. The adult parasites emerged August 16 and were found to be *Perilitus eleodis* Viereck.[1] This same parasite was reared from *E. opaca* on August 23.

A red mite, *Trombidium* sp., was found on a number of beetles collected July 3, 1917. These mites were attached to the legs and to the various sutures on the ventral side of the body. The beetles were placed in a cage but the mites soon disappeared and none of the beetles died.

A little life-history work was carried on with *Perilitus eleodis* and it might be of interest to note some of the results obtained. The larvæ emerge through the anal slit of the beetle and seek a place to pupate. As they move from place to place they leave a trail of silken thread and, where large numbers of larvæ emerged in a cage, the soil was often webbed together. Shortly after emerging the larvæ construct silken

[1] Determined by Mr. A. B. Gahan, of the Bureau of Entomology, U. S. Department of Agriculture.

cocoons in which they pupate. In spinning these cocoons the soil is webbed together, making it difficult to find them. In the rearing work, the larvæ would not construct cocoons unless there was soil present. The length of the pupal stage was determined for several hundred parasites and was found to range from 8 to 15 days, with an average of 9 days.

On emerging, the adults are rather active but make little effort to fly. On placing the parasites in cages containing adult beetles, they were found remaining close to the ground and apparently trying to get under the beetles. Shortly after introducing parasites into the cages, the beetles became frantic in their movements, running in every direction. The parasites could be observed clinging to the legs of the beetles and were apparently trying to oviposit in the abdominal sutures and at the junction of the legs and body. The parasites did not appear to mind being run over and carried around by the beetles but seemed intent on gaining hold on the ventral side of the abdomen.

Actual oviposition was not definitely observed and, owing to the chitinous integument of the beetle, it was impossible to dissect them and find the eggs. For this reason the length of the egg stage was not determined. The length of the egg and larval stages combined averaged about 12 days, with extremes of 10 and 18 days.

Large numbers of parasites may infest a single beetle, and as high as 124 larvæ were secured from an individual. The average number of parasites bred from a beetle was about 50. It is interesting to note that the beetles live from 12 to 48 hours after the larvæ leave the body and maintain most of their normal activities up to the time the parasites leave. One female deposited three eggs the same morning that she yielded 124 *Perilitus* larvæ.

The efficiency of this parasite in the field was not definitely established. In 1916, as high as 50 per cent of the beetles collected in August were parasitized, but, from the data at hand, it would seem that the average parasitism is only about 5 or 7 per cent. Of the 932 beetles collected in 1917, not a single one was parasitized.

Physiological Relations

Effect of Humidity.—Most of the species of the genus *Eleodes* are confined to the semi-arid regions of the United States west of the Mississippi River. They reach their greatest abundance, both in species and individuals, in those areas of little rainfall. As has been stated elsewhere in this paper, only three species have been authentically recorded east of Kansas. Owing to the wide distribution of *E. tricostata*, however, it is probably not as greatly influenced by moisture conditions as most of the species.

In the life-history studies, care had to be taken at all times to keep the cages moderately dry. When adults were placed in cages containing moist soil, oviposition decreased, and when they were placed in cages containing both moist and dry soil, they showed a great preference for the dry soil. The larvæ developed best in a slightly moist soil. When the soil was too wet to crumble nicely, the mortality increased greatly.

Blaisdell (1910, pp. 64–65) makes some interesting observations on the effect of moisture on the adults of *Eleodes* in general. He says that the individuals making up the specific aggregate do not necessarily breed true to any intraspecific degree of sculpturing, as this is wonderfully influenced by environment and food supply. The beetles that develop in an exposed or arid region where the body fluids are reduced to a minimum by evaporation during the latter stages and especially after the pupal skin is shed will have a comparatively smooth form of sculpturing. Conversely, beetles developing in a protected or moist region where the body fluids are conserved will have a more strongly punctured or strongly striate form. The dominant form of sculpturing is therefore determined by seasonal conditions, a hot, dry season producing a large number of the smooth forms and a cold, wet season the more strongly striate and punctured forms. There will also be a varying per cent of intermediate forms produced.

Effect of Light.—The larvæ of *E. tricostata* are negatively phototropic. When placed on the surface of the ground they immediately burrow into the soil. In all the studies so far made, larvæ have never been found on the surface of the ground. The adults, like most of the species of *Eleodes*, are generally nocturnal or crepuscular in their habits. They seek to avoid light in the field by hiding during midday under rocks, logs and manure, and also in burrows of other animals.

Measures of Control

E. tricostata has not as yet become of sufficient economic importance to warrant any extensive experiments on control. The use of poisoned bran was tried, under laboratory conditions, on the adults with good success but the larvæ lived for weeks on such a diet. With most of the injurious forms of *Eleodes*, it has been found possible to control them by summer fallowing the ground. This is a procedure that could be followed in western Kansas to a good advantage. Rotation is also recommended in some cases since the beetles are wingless and move only on foot. Hyslop (1912, p. 87) records his experience in treating seeds with various poisons to destroy the larvæ. Five or six poisons and repellents were used, all with negative results.

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SEASONAL IRREGULARITIES OF THE CODLING MOTH

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This paper includes a brief résumé of the observations that have been made relative to the behavior of the codling moth at Hood River, Oregon, during the years 1914, 1915, 1916 and 1917. The work has been conducted for its applicable value chiefly, in order that the local orchardists might be supplied with first hand information on the seasonal progression of this insect's activities, which would enable them to more intelligently and satisfactorily apply their lead sprays. Not being a major project, the investigation lacks many details that would more clearly demonstrate the very wide seasonal variations in the life-history of this apple insect from one year to another.

The two most important points that have been brought out in this study are, first, the very decided variation in the emergence of the broods from one season to another and its necessary influence on the timing and applying of sprays in order that control may be entirely successful. Secondly, the investigations indicate that sweeping recommendations given out often in the form of spray bulletins from a central or distant station are far from meeting the requirements in codling moth control in the different apple growing sections of the Pacific Northwest where vast ranges of conditions are found at relatively short distances. These ranges, due probably to temperatures, varying on account of altitudinal, coastal and interior influences, are such as to warrant seasonal studies of the insect in the different sections in order that a comprehensive knowledge of the insect's activities be available for the use of orchardists in their control measures. Until such stations of study are maintained we can expect a great deal of trouble from the codling moth in the Northwest. The variation in the life-history of the moth, which influences the timing of sprays, has been found to be of more importance in the control of the second generation of worms than the first brood, as in the case of the latter, conditions which retard vegetative growth usually directly influence insect activity with a result the standard spring applications—usually a combination insecticide and fungicide—can generally be effectively applied by following a prearranged spraying program.

The information gained and the points herein discussed have been obtained through yearly breeding cage studies and field observations of the different stages in the life-cycle of the codling moth. Properly prepared and watched, the breeding cage can be used by the investigator as a good index for the successful timing of sprays in order to get maximum control. However, in the hands of the novice, particularly one who is not very familiar with insect life, information gained from the cage can lead one astray. The writer has found some growers who can draw sound deductions, while for others, the interpretation would prove disastrous.

The breeding cage information gained by the writer during the past four years has on many occasions proved decidedly perplexing, and was only of value when carefully weighed with surrounding general field conditions. As an example of this: In 1915 we observed several moths issuing in the breeding cages as early as April 27, due to the fact that about a week of very warm weather occurred at that time. This was followed by cold, rainy weather during the remainder of the spring. No more moths issued in the cages for nearly a month and no eggs were found until May 28. This is only one of many similar observations. When problems arise that puzzle the trained investigator—who can make deductions of value only upon considering the problem from all angles—the orchardist stands little chance of gaining more than approximate information at best. In the absence of expert advice, however, breeding cage studies on the part of orchardists are to be encouraged. Its maintenance not only keeps them more keenly interested in habits and control but, if carefully attended to, serves as a very good indicator where developments are normal.

Breeding cages employed by the writer have been of two kinds: one a box 14 x 16 x 20 screened in on three sides by ordinary window screening, and the other the actual screening in of the trunks of apple trees which were known to harbor codling moths; in order to insure a good supply, trees were often banded before the brood left the fruit, following which the cages were attached.

For spring study of the insects' development, cages were always prepared and stocked with worms during the fall of the year. In so doing no unnecessary stimuli, showing itself either in the form of increasing or retarding emergence occurred. A much greater variation in the emergence of the moths has been noted where transfers from the tree trunks were made during the spring of the year. The mortality of spring transfers is also much higher, making it often difficult to gather accurate information. To facilitate the stocking of cages, trees were usually banded before the worms left the fruit. Many of the insects will establish themselves in the folds of the burlap, which is used, and

transferred to the cage, without disturbing them, if their cocoons have already been spun. Others can be readily removed from the trunk and be placed in the cages which have been provided with bark, chips and decaying bits of wood in which the larvæ burrow and spin their cocoons. To determine development from some of the worms which have not suffered transferring, worm-infested apples are placed in the cages; these apples are removed as soon as the worms have left the fruit.

The cages are distributed throughout the Valley at different altitudes. Commercial apple orchards are found at heights ranging from 100 to nearly 2,000 feet. The average seasonal variations in the two extremes given, has been found to be from fifteen days to three weeks for the first brood and about ten days for the second. In the emergence of the first brood a very definite progression from the lower to the higher elevations occurs; it is much less pronounced for the second, due probably to the fact that summer temperatures, during the day at least, are more nearly uniform throughout the Valley than are the spring temperatures.

TABLE I—MAXIMUM AND MINIMUM TEMPERATURE RECORDS FOR YEARS 1914-1917 INCLUSIVE, HOOD RIVER, OREGON

	1914		1915		1916		1917	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
April	62	53	64	39	62	39	54	36
May	73	58	65	42	64	41	62	43
June	72	50	74	49	73	46	74	48
July	82	53	78	56	73	50	84	52
August	82	52	84	54	79	52	83	52
September	67	45	..	..	72	45	72	48

As nearly normal orchard conditions as can be determined are taken into consideration when establishing the cages. This particularly refers to sun exposures, wind and rain, that emergence may be as nearly uniform to the surrounding orchard conditions as possible. As far as time has permitted, breeding cage observations and notes have been checked against field observations.

The accompanying table (Table I) summarizes the different points of greatest interest in the life-history of the codling moth during the past four years. In comparing the dates of emergence of the moths of the first brood over this series of years there occurred a variation of a full month and a half. A record was not obtained in 1914 but in 1915 the first moths issued in the cages on April 27. In 1916 this phenomenon occurred on May 26 and in 1917 on June 15. The question that

immediately presents itself is: what factor or group of factors is responsible for this very marked variation. A study of the existing weather conditions during these years assists to a large degree in supplying the answer.

Owing to the fact that the writer did not arrive in Hood River until the middle of July, 1914, observations were not taken relative to the weather conditions during the early season. However, a study of the daily weather report indicates that the temperatures for April, May and June for this year were exceedingly mild, the mean average temperature being much higher than in any of the other three years under consideration, and this is largely due to the fact that the average minimum temperatures were uniformly higher during the three months. The result was that codling moths issued in large numbers early in the season. This was followed by favorable weather conditions for egg deposition and hatching. Mr. G. F. Moznette, who made observations at Hood River on the activities of the codling moth during the spring of 1914, found eggs hatching in large numbers in several orchards on June 5. On this date many of the worms had entered the fruits. Summer weather during July and August continued favorable for development. The first worms were found leaving the apples on June 24; pupæ were noted on July 7 and moths emerged July 19. On July 27 the first eggs of the second brood were found on the fruit. The Station gave out, at this time, notices for growers to begin their spraying operations for the control of the second generation of worms.

In 1915, during the months of April, May and June there was much more fluctuation in the daily temperatures than in the corresponding time during 1914. The average maximum temperature for 1915 was practically the same as for 1914 but the minimum temperatures were very much lower. In 1915, due to this fluctuating daily temperature, breeding cage observations seemed of little importance when correlated with timing of sprays for the control of the first generation of worms. The latter part of April and the first few days of May were very warm resulting in the emergence of numerous moths in the breeding cages on April 27 and the days immediately following. At the time the calyx spray was being applied in an orchard in which the writer was carrying on experimental work many moths were flushed from the trees when the spray was thrown into the foliage. Following the sixth of May and continuing throughout the remainder of the month rainy, cold weather occurred. The influence of these conditions not only prevented emerged moths from depositing eggs but checked—practically stopped—emergence which had begun on April 27. Eggs of the codling moth were not found until May 28, one month after the emergence of the first insects. These were found plentifully during the month of June and

early in July. The first hatching eggs were noted on May 31. The average maximum temperature during July was about 6 degrees below normal which apparently retarded the development of the insects during this time. The first moths of the second generation issued July 26 and eggs were first noted August 10—14 days after the egg hatching of 1914. Growers were advised to have their spray on by the 12th or 15 days later than was recommended the preceding year.

The year 1916 proved to be one of more irregularities in the habits of the codling moth than of any ever previously studied by the writer. Spring and early summer seasons were very far from normal. The spring and early summer was cold and accompanied by many rainy days, and late summer, though fair weather prevailed, at no time did it become warm. The first moths issued in the breeding cages May 26 or at practically the same time eggs were present on the trees during the two preceding seasons. Emergence of moths was at its height between the 6th and 15th of June. On June 10 the first eggs of the season were observed. Beginning with the 17th of June (at which time egg deposition should have been at its height) rainy weather conditions set in which continued until July 4. During this time temperatures were very low, there being only five days during this period at which time the thermometer registered above 60 degrees at sunset (the theoretical minimum temperature required by the codling moth for the deposition of eggs). Of these five days, three registered 62 degrees. Eggs of the first generation were found present on the fruit as late as the 8th of August but at no time during the summer were they numerous.

Moths of the second generation were found for the first time on August 18, exactly one month later than in 1914 and 22 days later than in 1915. But very few second brood moths appeared in 1916; for the most part but one generation occurred. This definite statement can be made due to results of breeding experiments conducted to determine this point. Those worms which resulted from eggs deposited prior to the cold, rainy weather which extended from June 16 to July 4 produced second generation insects; those insects resulting from eggs deposited following this cold period failed to undergo any changes after they left the fruit and remained as larvæ on the trees until the spring of 1917.

The year 1917 was productive of still different irregularities in codling moth behavior. The past season has been one accompanied by heavy losses in many northwestern apple growing sections due to the great numbers of worms. Hood River was apparently more fortunate than most of the sections in this repsect but nevertheless losses in a good many orchards were serious.

In 1917 the early season was very backward, March, April and May

TABLE II—CODLING MOTH BEHAVIOR FOR THE YEARS 1914–1917 INCLUSIVE, HOOD RIVER, OREGON
(Compiled from Breeding Cage and Field Notes)

1st Moth Emerged	1st Egg Deposited	1st Egg Hatched	Egg Dep. Completed	1st Worms Leave Fruit	First Pupation
First Generation					
......	......	......	July 9	June 24	July 7
April 27	May 28	May 31	July 14	July 14	July 18
May 26	June 10	June 15	August 8	July 25	August 1-8*
June 15	June 25	June 27	July 26	July 20-26	July 26–August 2*
Second Generation					
July 19	July 27	August 2	September 25	September 5	September 20
July 26	August 10	August 12	......	......	August 31 (few pupa pres.)
August 18	August 25	August 28	late September	......	......
August 3	August 8	August 10	October 16	August 31	......

* Exact date not obtained.

were quite cold accompanied by many days of rain. This prevailing condition had a very marked influence on plant development; leaf buds on the apple trees did not begin to burst till the first of May. At this time during the years 1914 and 1915 the petals were falling followed shortly by the calyx spray. Even after this late bursting of the foliage, development continued to be very slow owing to the continued low temperatures. The average maximum temperature for the month of May was but 62 degrees. A temperature of 70 degrees was not reached until the last day of the month. With the arrival of June, weather conditions changed; continued warm, settled weather following June 4. The first moths, however, did not emerge in the cages until June 15. This observation was checked up with orchard conditions during this period and no moths were found to have issued under field conditions up to this time. This date was nearly a month and a half later than the first emergence in 1915 and 20 days later than in 1916. From June 15 on, however, activities of the moths progressed at war time speed. Favored with ideal weather conditions, the large numbers of worms which established themselves on the tree trunks and protected locations throughout the summer of 1916 issued as moths and apparently deposited their full quota of eggs. The first eggs were found on June 25, practically one month later than in 1915 and 15 days later than in 1916 which was in itself a late season. Hatching eggs were noted on June 27 and on July 26 or at the same time noted in 1916 worms were found leaving the apples to undergo their normal changes. On August 3 the first moths of the second brood issued and eggs were

noted on August 8, 17 days earlier than in 1916. In other words, codling moth activities started off one and a half months behind that of 1915 and by the time eggs of the second generation were deposited were just two days behind. The first brood of 1917 started off 20 days behind that of 1916 and by the time eggs of the second generation were deposited it had gained 17 days.

Prevailing warm weather continued throughout August, September and October during which time the second brood of insects was very active in 1917. Hatching of the eggs reached its height during the middle and latter part of August but continued until the fruit was harvested. Eggs on the fruit in the boxes were found while checking up experiments as late as October 16. This continued activity made it advisable for our station to recommend an extra moth spray, suggestions for the application of which were given out for September 5.

At this point the question might be asked whether it was not a partial third brood of insects which caused the deposition of eggs found late in October. A series of the earliest matured larvæ of the second generation were caged and their activities watched during the remainder of the season; in not a single instance did pupation occur. A study of this character has been conducted during some of the other seasons but up to the present time no indications of the occurrence of a partial third generation has been observed at Hood River.

As a general practice in the past in most of the sections of the Northwest, spraying for the control of the second generation of worms has been supposed to be necessary between the 25th of July and the first of August. This was the belief of local orchardists at the time the writer began the study of this insect at Hood River. In 1914 the study checked up nicely with these suppositions; the 27th of July being the time recommended for spraying. In 1915 the spray was applied most effectively August 12; in 1916—where it was necessary—August 28; and in 1917 on August 12. In two years out of the four the recommended date for applying the summer application of arsenate of lead was the same; with the extremes there was more than a month's difference. Those of you not entirely familiar with codling moth control might ask the question: What material difference would it make if the spray was applied even 10 or 12 days before egg hatching? The answer would be in terms of obtainable results in ordinary seasons of infestation, the difference between complete control as against one half or even less control. In other words, an application of spray cannot be completely effective during a period, not to exceed 20 days at this time of the year, owing to the rapid growth of the fruit and its necessary partial uncovering. If a spray is applied 10 days in advance of the brood hatch, one half of its complete effectiveness is forfeited at the

time the application is made. Effectiveness in codling moth control rapidly decreases at the end of twenty days. Egg hatching activity, on the other hand, under normal conditions, is usually approaching its height ten to twelve days following the hatching of the first eggs. At this time, then, a maximum need for protection is demanded and the effectiveness of the application of spray is rapidly decreasing. A large percentage of the losses that result and poor control obtained on the part of orchardists can be traced to this source.

The reduction of time of application of a spray to the shortest safe period preceding egg hatching will only be productive of good results. Very close timing, in the case of protracted egg hatching, will often save an extra application of spray and much unnecessary expense. To accomplish this end it is necessary to obtain a very intimate knowledge of the insect's seasonal behavior and demands a careful investigation in the different sections by a thoroughly competent investigator.

It is the belief of the writer that the losses due to the activities of the codling moth in the Northwest can only be reduced to the minimum through the establishment of observation stations in the widely separated apple growing sections. An investigator located in some of these sections during the past year could have saved his community enough to maintain a station for at least twenty-five years.

SOME FACTORS INFLUENCING THE DISTRIBUTION OF PEMPHIGUS BETÆ DOANE IN BEET FIELDS

By Asa C. Maxson, *In charge of Insect Investigation*, The Great Western Sugar Co., Longmont, Colo.

The sugar beet root-louse, *Pemphigus betæ* Doane, presents one of the most serious insect problems which confront the beet sugar industry of the Western States.

The seriousness of this insect's injury immediately becomes apparent when we realize that the difference between the sugar actually produced and what could be produced from the same acreage, were it possible to prevent this injury, amounts to a loss of several hundred thousand dollars annually to the industry.

In the course of his work with this insect, the writer has been continually impressed by the fact that our knowledge of the factors operative in its dispersion and distribution in the sugar beet growing areas of the west is altogether inadequate. This led to the making of a preliminary field survey during the growing season of 1916, it being hoped that something might be learned that would eventually result in the develop-

ment of better means of controlling this pest than we have at the present time.

This work was undertaken for the express purpose of studying the relation of previous crops and the presence of the winter host tree, *Populus angustifoliæ*, to the degree of infestation.

The areas covered will be known in this report as the Longmont and Eaton territories. The former extended from the foothills of the Rocky Mountains, in Boulder County, eastward a distance of 18 miles, contained 44,800 acres and 410 beet fields. The latter, which is in Weld County, was 14 miles long, lay parallel to the mountains with its western boundary 24 miles to the east of them. This territory contained 32,000 acres and 253 beet fields.

Owing to the topography of the country and the shape of the beet growing areas these territories are naturally divided into sections. The Longmont territory is divided into 3 sections. What will be known as the river section is the most westerly and extends in a narrow strip each side of the St. Vrain River from the foothills to the city of Longmont, a distance of 9 miles. Northeast of this is the central section, a rectangular area 4 miles east and west and 5 miles north and south. East and a little north of the central section is the eastern section. This is also a rectangular area. It is 5 x 6 miles, the 6-mile side running east and west.

The Eaton territory is divided into a north and a south section. The former lies north and west of the town of Eaton. It is rather irregular in shape, being 8 miles north and south with an average width of 3.5 miles. The latter lies south and east of Eaton. North and south it is 6 miles and has an average width of 3.75 miles.

As already stated, the main object in making this survey was to study the relation of previous crops and the presence of the winter host to the degree of infestation. However, it was found that another factor would have to be taken into account in working up the results of the survey, *i. e.*, what the writer calls the "time factor." The effect of this and the "previous crop" and "winter host" factors will be considered in the following pages.

THE TIME FACTOR.—There is no doubt that the original infestation in all beet fields is due either to the hibernating, wingless lice or the spring migrants which come from the winter host. This being the case, the number of infested beets should not change after migration from the trees ceases (which is about August 1 at the latest with us), unless the lice migrate from beet to beet in the field. That this actually takes place is shown by the following observations.

An examination of several beet fields during August and September revealed many wingless lice and pupæ leaving the soil, climbing up the

leaf stems and crawling about on the surface of the ground. This was especially noticeable after the beets had been irrigated. The wetting of the lower levels apparently drove the lice to the surface. During their wanderings many became located on beets which were uninfested up to this time.

In order to ascertain to what degree the infestation increased, 300 beets were pulled once a week from a small plot in the experimental field at Longmont and a record made of the number infested. The first 300 were pulled on August 12, at which time 68 beets out of every 100 were infested. One week later the infestation had reached 75 per cent. By the end of the next week 100 per cent were infested.

The action of this factor makes it impossible to make some very desirable comparisons; however, the survey was made in such a way that many interesting comparisons are possible.

THE PREVIOUS CROP FACTOR.—The fact that rotation is of little or no value in the control of the sugar beet root-louse has long been apparent. The results of this survey seem to prove quite conclusively that rotation is of no value as a means of reducing the losses due to this insect.

In the following tables all fields in the Longmont and Eaton territories are arranged according to the previous crop.

LONGMONT TERRITORY

Previous Crop	*Per Cent Infestation*
Beets	85.70
All grains	82.31
Alfalfa	82.09
Mixed crops	78.71

EATON TERRITORY

Previous Crop	*Per cent Infestation*
Potato	89.6
Alfalfa	83.7
Mixed	82.4
Beets	81.0
All grains	79.5

A comparison of these tables reveals the fact that the different crops do not hold the same relative place in the two territories. This would appear to more fully prove the correctness of the statement already made that rotation has little if any value as a control for this insect.

THE WINTER HOST FACTOR.—This of all the factors thus far studied appears to be the most active in the spreading of the sugar beet root-louse in northern Colorado. A comparison of the degree of infestation in all fields in those parts of the territorial sections where the narrow-leafed cottonwood trees are most abundant and those parts where these trees are relatively few, results in some very interesting figures.

All along the foothills and in the canons through which the streams

which water the eastern plains make their way out of the mountains great numbers of narrow-leafed cottonwood trees are to be found. Normally these trees are very heavily infested with the gall form of *Pemphigus betæ*. As we go eastward following the water courses, these trees gradually give place to the broad-leafed cottonwood, *Populus occidentalis*. Thus we find that in a strip 100 yards wide passing through the timber belt along the St. Vrain River at the west end of the river section there were 282 narrow-leafed cottonwoods and 6 broad-leafed ones. In a similar strip passing through the center of this section there were 429 narrow-leafed and 30 broad-leafed cottonwoods, while in a strip passing through the eastern portion of the section contained 185 narrow-leafed trees as against 134 broad-leafed ones.

Comparing all fields in the western half of this section with those in the eastern, we find that of those of the former portion 100 per cent have an infestation of over 70 per cent and of those of the latter but 97.5 per cent have an infestation of 70 per cent or above.

When we compare all fields within one-half mile of the river with all those more than this distance from it we find that those nearest the river and the narrow-leafed cottonwood trees in the timber belt along it have the heaviest infestation. Of the beets in those fields within the one-half mile limit, 87.07 per cent were above 90 per cent infested while of those in the fields outside of the one-half mile limit but 76.75 per cent were infested to a like degree.

An examination of the central section of the Longmont territory brings out the relation of the winter host and the infestation still more strongly than the preceding.

In the western half of this territory there are 244 host trees and in the eastern half but 25. The per cent of all fields in the two halves of this section which have an infestation of over 70 per cent was 46.6 for the western and 35.7 for the eastern half. If we divide this section into halves by drawing a line from east to west, we find that the per cent of fields with an infestation of over 70 per cent is 56.6 for the north and 34.2 for the south half. There are 187 narrow-leafed trees in the north half and but 82 in the south. Now if we place all fields in this territory into two groups, one including all fields within one-half mile of narrow-leafed cottonwoods and the other including all fields at a greater distance from these trees, we find that of those within the one-half mile limit 46.42 per cent have an infestation of over 70 per cent while of those outside this limit but 36.95 per cent are infested to this degree.

Likewise in the eastern section 69.7 per cent of all fields in the west half, with 571 narrow-leafed trees, have an infestation of over 80 per

cent while of those in the east half where there are but 22 narrow-leafed trees, 65.96 per cent have a like infestation.

In the north half of this territory there are 156 narrow-leafed cottonwood trees and in the south half 437. Of the fields in these halves 78.6 per cent of those in the north and 84.6 per cent of those in the south half have an infestation of over 70 per cent.

If we compare all fields within one-half mile of narrow-leafed trees with all those from one-half to three-fourths and all over three-fourths mile of these trees we find 78.57 per cent, 60 per cent and 54.76 per cent respectively of the fields in the three zones have an infestation of over 80 per cent.

In making similar comparisons in the Eaton territory we find the same higher degree of infestation in fields within one-half mile of narrow-leafed cottonwood trees.

We also find that the western halves of both the north and south sections of this territory carry a heavier infestation than the eastern halves. In these sections it cannot be due to trees within the territories, as the northern section is nearly treeless and contains but one narrow-leafed cottonwood which is near the southwest corner of the section.

The south section has 46 trees of this species, 41 of which are in the southwest corner and five near the southeast corner. When the survey was made no galls of *Pemphigus betæ* were found on any of these trees, most of which were small second growth stock or sprouts coming up about stumps of larger trees which had been cut down the year previous.

The heavy infestation of the west as compared with the eastern portion of these sections suggests the effect of the wind which is no doubt an active factor in the dissemination of the beet root-louse. Just how far the beet root-louse is carried by the wind has not been determined. During early summer, while the heaviest migration of this insect from the winter host is taking place, the prevailing winds of northern Colorado are westerly. It does not seem unreasonable that these insects might easily be carried from the mountains, many miles out on to the prairies by these winds.

West of the northern section of the Eaton territory there are several miles of practically treeless, unirrigated land. The Cache La Poudre River passes just southwest of the southern section of this territory. Along this stream there is a timber belt of varying width within which there are some narrow-leafed cottonwoods. It is probable that the infestation of the Eaton territory comes largely from these trees if not from the mountains.

This survey has been continued during the present summer in the

Longmont territory over an area of 161,280 acres and in the Sterling territory, which is in the northeast corner of the state on the South Platte River. This latter territory covers an area of 38,400 acres. It is hoped that when the results of this study are worked up some valuable information will be secured.

THE PINK BOLLWORM (GELECHIA GOSSYPIELLA) IN EGYPT

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Seconded for temporary service in Egypt by permission of the Colonial Office

Native Home and Distribution

The pink bollworm appears to be a native of India and the southern Asiatic region. It was introduced into Egypt in badly ginned cotton lint. The importation of cotton from India into Egypt occurred between the years 1903 and 1913. The following table shows the amount of cotton so imported:—

Year	*Quantity in Kilograms*	*Year*	*Quantity in Kilograms*
1903	20,510	1909	31,206
1904	25,827	1910	13,353
1905	9,150	1911	......*
1906	81,240	1912	10,998
1907	162,000	1913	89,995
1908	21,460		

* No importations.

It was found in 1913 that a very considerable number of cotton seeds occurred in this cotton and that in these seeds considerable numbers of pink bollworms were found.

Since that time cotton seed from Egypt has been imported into Brazil and Mexico and as a result pink bollworm is now established in those countries.

At the present time the pink bollworm is known to occur in: Asia—India, Ceylon, Burmah, Straits Settlements, The Pacific Islands—The Philippines and Hawaiian Islands. Africa—Egypt, Sudan, East and West Africa, Nigeria and Zanzibar. In the Western Hemisphere the pink bollworm now occurs in Mexico and Brazil where it has recently become established as a result of the introduction of Egyptian cotton seed for planting.

Food Plants

In Egypt the pink bollworm is known to attack cotton of all varieties, teel or Indian hemp (*Hibiscus cannabinus*), bahmia or okra (*Hibiscus*

esculentus) and holly-hock (*Althea rosea*). The record of pink bollworm in Egypt being bred from pomegranate is evidently an error and probably resulted from the use of a breeding cage which had formerly been used in connection with gelechia-infested cotton seed for containing a diseased pomegranate.

In India, the pink bollworm is stated to feed upon the oily seeds of several trees, not being confined to the same natural order as the cotton plant. In Hawaii, the pink bollworm is said to feed upon the seeds of a Malvaceous tree, the Milo (*Thespesia populnea*).

The egg of the pink bollworm is very small and inconspicuous. The eggs are deposited singly or in groups not often exceeding four or five together. They are laid on the food plant of the larva, the preferred situation on the cotton plant being on the boll.

Life-History and Habits

The duration of the egg stage is some four to ten days, after which the eggs hatch and the young larvæ issue.

The larva at first is yellowish-white in color with brown head and brown thoracic shield. Later, the body of the larva becomes tinged with pink, this pink color being deposited principally in broad bands across the back and extending down upon the sides. In well colored specimens the whole body appears pinkish.

When first hatched the larva proceeds to tunnel into the boll and to penetrate into the interior of the seed. The duration of the larval stage occupies, in summer, about 20 to 30 days. During its life, the larva probably consumes more than the contents of one seed, but usually its feeding is all done within one boll. When very young bolls or flower buds are attacked they are entirely destroyed; very young seeds are also completely destroyed, while the seeds which are attacked at a later stage of their growth may be only partly consumed.

The full-grown larva spins its cocoon and enters the pupal stage either in the boll or at the base of the boll protected by the bract, or, most often, they descend to the ground and pupate amongst the particles of soil, bits of leaf, fallen flowers or other loose material on the surface. The pupal stage occupies about 10 to 12 days, after which the moth emerges.

Two or three days after the emergence of the moth, egg laying begins. It is probable that this extends over only a few days more, the whole life of the moth not exceeding two or three weeks under ordinary conditions.

The whole life-cycle occupies some four to five weeks at that period when the temperature and the condition of the plant is most suitable for the development of the insect. Later in the season when the

weather is getting cooler and the cotton plants are ripening, this time is somewhat extended.

The moths are very rarely to be seen in the fields, although they may be there in enormous numbers. They hide during the day and it is practically impossible to disturb them into flight. At night, probably in the two or three hours immediately following sunset, they are active. It is at this time that feeding, pairing of the sexes and egg laying take place.

In Egypt, experiments have shown that the moth is attracted to light. In Hawaii, Mr. August Busck found that the moth was not attracted to light.

The following tables give the figures showing the number of moths captured by single light traps in two different situations. Light traps in the field, however, have not given any results in the control of attacks by this insect.

Table Giving Numbers of Gelechia Moths Captured in Light Trap in Insectary at Ministry of Agriculture, from Cotton Bolls, in Heap on the Ground and in Trays, from April 2 Onward. The Trays and Bolls Contained in Them were Removed May 3 to Another Room. From May 4 the Trap was Alternated in Four-day Periods between No. 1 Room Containing Heap on the Ground and No. 2 Room Containing Bolls in Trays.

Day of Month	April	May		June		July		August	
		1	2	1	2	1	2	1	2
1	No light	No light experiments with baits		..	3	2	..	26	..
2	68			..	1	2	..	15	..
3	33			..	1	..	0	13	..
4	41	41	..	..	1	..	2	..	0
5	20	58	..	28	..	..	1	..	1
6	90	69	..	9	..	..	1	..	1
7		60	..	9	..	2	..	..	4
8	54	..	9	11	..	3	..	..	0
9	42	..	3	..	1	1	..	54	..
10	45	..	3	..	1	6	..	35	..
11	73	..	4	..	1	..	0	34	..
12	50	120	..	..	0	..	0	37	..
13	88	45	..	0	..	..	1	..	1
14		46	..	13	..	..	1	..	2
15		60	..	7	..	9	..	..	3
16	250	..	2		..	4	..	..	0
17		..	2	..	0	4	..	81	..
18	150	..	2	..	2	7	..	30	..
19	103	..	3	..	0	..	1	38	..
20	93	84	..	..	0	..	2	29	..
21		27	..	13	..	..	1	..	0
22	167	19	..	5	..	..	1	..	2
23	254	53	..		..	8	..	..	1
24	331	..	0	3	..	11	..	..	1
25	300	..	1	..	0	15	..	97	..
26	168	..	0	..	3	13	..	35	..
27	10	..	0	..	0	..	1	40	..
28	50	79	..	..	0	..	0	32	..
29	72	18	..	5	..	..	0	..	0
30	50	19	..	2	..	..	1	..	0
31	..	19	..	..	..	51	..	..	1
									1
Total	2,602	827	29	105	14	138	13	596	18

The light trap used in obtaining the catches recorded in both these tables consisted of an electric light bulb suspended above a pan of

water with a film of kerosene on it. The surface of the water was about 3 feet above the floor level.

TABLE GIVING NUMBERS OF MOTHS CAUGHT IN LIGHT TRAP IN LARGE COTTON SEED STORE AT ALEXANDRIA IN 1917

Date	Moths	Date	Moths
June 21	25	July 13	97
June 22	20	July 14	107
June 23	15	July 15	236
June 25	57	July 16	
June 26	32	July 17	137
June 27	26	July 18	180
June 28	25	July 19	180
June 29	18	July 20	800
June 30	33	July 21	
July 1	65	July 22	
July 2		July 23	
July 3	20	July 24	80
July 4	26	July 25	60
July 5	28	July 26	40
July 6	25	July 27	40
July 8	52	July 28	27
July 9		July 29	20
July 10	68	July 30	
July 11	72	July 31	12
July 12	80	August 1	5

The seed store at Alexandria in which the light trap catches were made, as recorded in the preceding table, was emptied of seed on August 4. New seed from Upper Egypt and the Fayoum began to arrive in this store on August 15. This seed represents the first picking, in 1917, in certain districts.

The numbers of moths caught by the traps each night remained at about the same figures, that is, from 2 or 3 to 15 or 20 until September 1, when the numbers showed a distinct use. In the interval from August 15 to September 1, the emerging moths were probably from scattered seed and pupæ which had been formed between planks in the floor and in crevices in the walls and these represented the resting-stage larvæ from the previous season.

The great increase in numbers, after September 1, was due to the emergence of moths from the short cycle larvæ of the 1917 crop.

The following figures give the catches for each night. It will be noted that on the night of September 11–12 there was no light, and the trap caught only 8 moths, the windows of the seed store being closed. Closing the windows or leaving them open during the night does not seem definitely to affect the catch in the trap.

The Resting Stage

The most important feature in the life-history of this insect is what is called the resting stage of the larva. This resting stage appears to be an adaptation of the insect to its environment. For some reason or in response to some stimulus which is not at present understood, certain of the larvæ, after becoming full grown, spin a special kind of cocoon

TABLE SHOWING CATCHES IN LIGHT TRAP IN SEED STORE* AT ALEXANDRIA, SEPTEMBER 1–17. NEW SEED OF 1917 CROP BEGAN TO ARRIVE IN THIS STORE AUGUST 15

Date, 1917, Morning of	Number of Moths	Windows Open or Closed at Night
September 1	32	......
September 2	265	......
September 3	.....	......
September 4	191	Open
September 5	184	Open
September 6	318	Open
September 7	943	Closed
September 8	2,470	Closed
September 9	4,500	Closed
September 10	7,960	Closed
September 11	5,500	Closed
September 12	8	Closed
September 13	6,060	Closed
September 14	5,760	Open
September 15	2,800	Closed
September 16	5,500	Open
September 17		

* The windows in this seed store were open all day and every day for ventilation. They were closed at night, all through the summer, until September 4.

in which they pass a period of time, varying greatly in length, after which they come out and spin the ordinary cocoon in which the pupa is formed.

In the early part of the season nearly all the larvæ proceed at once to pupate and complete their development. As the season advances an increasing number of them enters the resting stage until, at the end of the season, nearly all follow this course.

It is in the resting stage that the insect passes through the winter or through the period between one crop of cotton and the next, and it is consequently in this condition that it offers the best opportunity for methods of control to be applied.

The eggs are very small and inconspicuous, and the egg stage is short, the larvæ spend all their existence within the tissues of the plant, the pupa is small, well hidden, and occupies a short period of time and the moths are very difficult to find even when they are very abundant. None of these stages offer any satisfactory opportunity for control methods except during that part of the larval life which is called the resting stage.

Resting-stage larvæ are mostly to be found within the cotton seeds. These seeds may be in the seed cotton which is removed from the field as the crop, or they may be in the seeds in bolls which are left attached to the plants or scattered on the ground after the crop is removed. Often two or more seeds are fastened together by the larva in such a way as to allow of its passage from one to another. The presence of "double" seeds is a sure indication of attack by the pink bollworm, but many resting larvæ occur in single seeds. Double seeds are found in the seed cotton, in cotton seed, and in the bolls left in the field after the crop is harvested.

For the control of this insect it is necessary to destroy the resting-stage larvæ at the end of the cotton season. This work falls naturally under two headings—the destruction of all bolls left in the field after the crop is harvested and the destruction of the larvæ in the cotton seed after the cotton is ginned.

Control Measures

In Egypt a law has been passed requiring the destruction of the bolls on the plants and of all that may have fallen to the ground immediately after the crop is finished. A law has also been passed requiring that every ginnery shall be provided with a suitable machine for the treatment of cotton seed as it leaves the gins, for the destruction of the pink bollworm larvæ in the seed.

On account of the difficulties which arise from the war, in obtaining the necessary machinery, this law has not yet been put into force. Experiments have been made, however, with machinery for the treatment of seed by means of heat and there appears to be no difficulty in killing all the worms in the seed without affecting the quality of the seed either for the purposes of planting or for the production of oil.

The use of hydrocyanic-acid gas and carbon bisulphide does not seem to be practicable under the existing conditions in Egypt. The highly poisonous nature of hydrocyanic-acid gas requires the employment of careful and responsible labor in its application and this is not to be had in the ordinary way in the cotton ginneries in Egypt. Further, it is objected that in such a densely populated country the liberation of large quantities of poisonous waste gases would be likely to be injurious to public health. Carbon bisulphide, on account of its highly inflammable and almost explosive character, is not suitable for use in close proximity to cotton ginneries where the atmosphere is laden with the fine particles of cotton which, in the event of fire, are also highly inflammable.

As far as Egypt is concerned, hot air seems to be the most suitable agent for the destruction of the pink bollworm in cotton seed at the ginneries.

The pink bollworm campaign which is carried out under the direction of the Ministry of Agriculture has for its object the destruction of the bolls left in the fields after the crop is harvested. The season of 1916–1917 was the first one in which this campaign was well organized and thoroughly carried out. The results obtained from this campaign although not altogether satisfactory have been very useful. A very large proportion of the bolls were destroyed.

The law required that the bolls should be cleaned from the standing

plants and burnt and that all fallen bolls should be collected from the ground and burnt before the cotton plants were cut or pulled.

In cases where this was not done before the prescribed time the cotton sticks were seized and destroyed by the officers of the Ministry of Agriculture. The value of the sticks destroyed in this manner is estimated at L. E. 87,000.[1] In Egypt, the scarcity of fuel gives to the cotton plants a value which they probably possess in no other cotton growing country and it is because of this that attempts are made to have the bolls cleaned from the plants instead of having them uprooted and burnt.

The prospects for the control of the pink bollworm in the future are distinctly hopeful. During the past season much opposition was met with on the part of the ignorant and superstitious peasantry while the village officials failed to give that assistance which might reasonably be expected of them, and in some instances even directly opposed the efforts of the Ministry of Agriculture.

In succeeding years, however, it is to be expected that the peasants will realize more and more the usefulness of this campaign and that the village officials will render valuable assistance. In the past season also, as a result of the war, there was a shortage of English officials and the native subordinate officials were all new to the work and had to be trained in their duties.

When the working of the field campaign has been improved and the ginneries are equipped with suitable machines for the treatment of seed, there is every reason to hope that the pink bollworm will be controlled to such an extent as to impose only normal losses on the cotton industry of Egypt.

There is no hope that the pink bollworm will ever be exterminated and so far as at present known there seems no likelihood of its ever being controlled to a satisfactory extent by its natural enemies.

The Nature and Amount of Loss Caused by the Pink Bollworm

The pink bollworm causes injury and loss to the cotton by injuring the seed and by reducing the amount of lint produced. The quality of the lint is also seriously affected. Young bolls are attacked and completely destroyed, while, when flower buds are attacked, these are destroyed and no flowers produced.

When a seed is attacked at an early stage of its growth not only is the seed completely destroyed, but no lint is produced by it. Later on, seeds may be attacked when they have formed all or part of their lint. In such cases, it is easily seen that a considerable amount of damage

[1] The L. E. = about $5.00.

may be done to the seed without causing very much loss in the amount of lint produced, although its quality may be affected.[1] A certain amount of damage is also caused by the tunnels of the larvæ through the boll. The lint is stained either by the larva or by fungi or bacteria which attack the injured tissues. Another and important injury is that which results in producing a dead or unopened boll or sections of boll. In these, the cotton remains matted, failing to open properly and is often discolored.

The amount of loss resulting from the attacks of the pink bollworm is very difficult to estimate. In Egypt, for something like twenty years past the average yield of cotton per feddan has been steadily decreasing but there has not been, since the advent of the pink bollworm, any acceleration in the rate of this decrease. The crops of the past three or four years have been slightly smaller than those of the previous few years. The following figures show the yield per feddan for the period 1894–1916 and the means of average yields for the last four five-year periods.

TABLE SHOWING AVERAGE YIELD OF COTTON IN EGYPT FOR THE YEARS 1894–1916

Year	Yield in Qantars* per Feddan	Year	Yield in Qantars per Feddan
1894	4.78	1906	4.61
1895	5.27	1907	4.51
1896	5.60	1908	4.12
1897	5.80	1909	3.13
1898	4.98	1910	4.57
1899	5.64	1911	4.31
1900	4.42	1912	4.35
1901	5.10	1913	4.45
1902	4.58	1914	3.67
1903	4.88	1915	4.05
1904	4.39	1916	3.64
1905	3.80		

* The qantar=99.05 lbs.; the feddan=1.038 acres.

The means of the average yields for 5-year periods are:

1897–1901	5.09 qantars
1902–1906	4.45 qantars
1907–1911	4.12 qantars
1912–1916	4.03 qantars

There has been a great fluctuation in the price of cotton owing to the war which makes it extremely difficult to place a money value on the losses caused by the pink bollworm. It would appear, however, from

[1] Attacked seeds lose in weight: They may be entirely destroyed, or may be injured in varying amounts, some, although attacked, being nearly of full weight and producing almost a normal amount of lint.

Another form of injury by the pink bollworm is the loss in weight of seed, in weight of lint, in germination of seed and in quality of lint in the case of unattacked seeds in locules in which other seeds have been attacked.

figures already at hand that the losses resulting from the attacks of this insect may be taken at 10 per cent of the total crop of cotton in Egypt during the past two or three seasons. If this is calculated on the amount and value of last season's crop (1916) we get the following figures:

The total crop of cotton was about 6,000,000 qantars, 10 per cent of which would amount to 600,000 qantars. The average price per qantar for the season may be taken as between 30–40 dollars.[1] At the former price this would mean a loss of L. E. 3,600,000 and at the latter a loss of L. E. 4,800,000. These figures are probably under rather than over the amount of this loss, but, whether they are accurate or not they indicate, strikingly, the very large toll which this insect takes from the cotton industry of the country, and they should serve as a warning to any country in which the pink bollworm does not occur to take every precaution against its introduction.

Natural Enemies

The natural enemies of the pink bollworm do not occur in sufficient numbers or at the right time of the year to exercise any great degree of control over this pest in Egypt.

The insects known to be parasitic or predaceous on the pink bollworm are:

Pimpla roborator, *Chelonella sulcata*, *Rhogas kitcheneri*, a Pteromalid and *Pediculoides ventricosus*.

Pimpla roborator is a general parasite in Egypt. It appears to attack the pink bollworm only late in the season, too late in fact to exercise any control over the amount of damage to the cotton in that season. The practice of burning the bolls left after the cotton is harvested destroys large numbers of this parasite. This is the only parasitic insect which has been bred in large numbers from the pink bollworm.

Chelonella sulcata at present is known in Egypt only as a parasite of *Gelechia gossypiella* and has been known in this country only since the advent of this pest. Up to the present time, it has not been recorded in large numbers.

Rhogas kitcheneri and the small Pteromalid—*Pteromalus* sp., are general parasites which are known at times to attack the pink bollworm.

Pediculoides ventricosus sometimes occurs in great abundance in cotton seed stores and causes the death of large numbers of Gelechia larvæ. There is no certainty that this mite is capable of penetrating into infested single or double seeds containing resting-stage larvæ if nothing has happened to render the union between the double seeds

[1] The dollar = 20 piastres tarif = $^1/_5$ of the Egyptian pound (L. E.).

or the covering over the entrance to the infested single seed less impenetrable than they were made by the larvæ. The action of the cotton gins may result in loosening the silk spun by the larvæ sufficiently to allow for the entrance of the mites.

Any larvæ that come out of the seed in a mass of seed where Pediculoides occurs abundantly are almost certain to be attacked and killed by this mite, especially late in the season.

The two principal natural enemies are then Pimpla and Pediculoides. Pimpla occurs in some numbers but the bollworm campaign in Egypt should result in all the bolls remaining in the field after the crop being destroyed before the time of the greatest emergence of the parasite, and Pediculoides occurs in numbers only in the storehouses later in the season. When the ginneries are equipped with machines for treating the seed as it leaves the gins, the predaceous mite will cease to be of any importance in connection with the control of pink bollworm in cotton seed.

NOTES ON THE WOOLLY APHIS

By Geo. G. Becker, *Fayetteville, Ark.*

Owing to the war and to the uncertainty of concluding investigations as planned, the writer is submitting in this paper the results of investigations with the woolly aphis, *Eriosoma lanigera* Haus., which had as their aim (1) the working out of the life-history of the insect in the Ozarks, (2) studying the relative immunity of various hosts of this insect and of the relationship of these hosts to the species, (3) studying the immunity of Northern Spy stock to the attacks of this species, and (4) determining whether *Eriosoma cratægi* Oestlund is a synonym of *Eriosoma lanigera* Hausmann.

In the Ozarks the species winters on elm in the egg stage and on the roots of apple and in wounds, knots and rough places on the trunk above the ground, of apple and Cratægus as apterous viviparæ. The occurrence of overwintering apterous viviparæ above ground on apple or Cratægus is uncommon in this latitude as the aphids seem unable to withstand the low temperatures.

The overwintering eggs on elm probably hatch sometime between the first and the middle of March. In 1916 we found stem-mothers in about the third instar by the 30th of March. At this time the buds, with the exception of the infested ones, had not pushed through.

The second generation begins to make its appearance by the first of April. In 1915 a stem-mother was found on April 20 with about 20 or more young, in 1916 we found a stem-mother on April 6 with

about 15 young and in 1917 we found stem-mothers on April 14 with colonies of young.

The third generation probably makes its appearance a little after the middle of April or possibly even sooner.

In 1915 we observed the mature winged individuals of this generation on May 5. In 1916 we observed a colony on May 12 in which 25–50 per cent of the individuals were winged. In 1917 we found the first winged individuals as early as April 27. Under optimum conditions winged individuals from elm might be found from this time on until nearly the last of July. We have found them as late as July 21. Parasites usually cut this generation short so that under normal conditions it is difficult to find the species on elm after the first week of June.

We have not worked out the number of generations of aerial apterous viviparæ occurring on Cratægus and apple. Fall migrants make their first appearance with us by the middle of September and in favorable seasons may be found as late as the middle of November. There would thus be a period of five months between the appearance of the first spring migrants and the first fall migrants and a period of four months between the last spring migrants and the first fall migrants. If the aerial viviparæ mature in the same time that the root forms mature (15–25 days), there would certainly be time for the development of more than two generations as recorded for Maine by Miss Patch[1] and for Vienna, Va., by A. C. Baker.[2]

On the roots of apple the apterous viviparæ become active by the first of March and continue active until along in November. From the data which we have, this would make it possible for six to twelve generations to develop during the course of a year.

Experiments with Spring Migrants

With a view of determining whether the young of individual migrants would establish on either elm, Cratægus or apple, a series of experiments was begun in which some of the young of each migrant tested was placed on each of the hosts. A safer and more satisfactory method of distributing the young consisted in transferring the migrant from host to host and permitting her to deposit young on each. We found that once a migrant begins to deposit young she usually continues to deposit them in rapid succession until exhausted.

In no case did the offspring of the migrants find elm congenial. In view of the fact that many elms are immune to the insect and that

[1] Maine Agricultural Experiment Station Buls. 220 (1913) and 256 (1916).

[2] Report No. 101, U. S. Department of Agriculture, Office of the Secretary, 1915.

on trees not immune aphids establish only under peculiarly favorable conditions, the experiments with elm cannot be regarded as satisfactory.

In these and subsequent experiments young seedling apple trees and young seedlings of *Cratægus crus galli* were used. Following are the results of experiments with apple and Cratægus.

TABLE I

	No. Migrants Tested	No. whose Young Est. on Both Hosts	No. whose Young Est. on Apple Only	No. whose Young Est. on Cratægus Only
1915	12	4	1	4
1916	5	0	1	0
1917	18	0	16	0

The above does not give us as much data as we would like but these tests along with other tests not recorded in this paper show the marked immunity of Cratægus as compared with apple. The difference in the results of the three seasons suggests that in addition to an inherent immunity, Cratægus may have a conditional immunity depending upon the season. This is further suggested by our experiments with Cratægus seedlings.

Our spring migrants seemed to be slightly more prolific than Baker's, averaging usually from 7 to 8 per female instead of 6 as reported by Baker for Vienna, Va. One individual under our observation deposited 19 young. Another deposited 18.

Experiments with Elm

In our observations on elm we were impressed at the earliness with which the stimulative effect of the aphids affected the leaves. It appeared that the aphids must have attacked the leaves almost before they had pushed through the bud or at least just as soon as enough was through for them to work on. At any rate the attacked leaves pushed through and curled at once before the normal buds had pushed out. Terminals where embryo colonies were forming were conspicuous on the trees before the normal buds had burst. In the accompanying plate are pictures of normal and infested buds which were collected from the same tree and at the same time, April 6, 1917.

The difficulty which Baker had in getting this insect to establish on elm was witnessed by us. We tried repeatedly to establish second and third generation larvæ on various potted elms but without success. It was noticed on our campus that there was a marked variation in the immunity of various elms to this insect. Near our insectary we have noticed an elm to be infested every year for the last five years

and during the same time numbers of elms which are near it have never been observed to be infested.

It appeared from general observation that backwardness of growth was associated with susceptibility to the attacks of the insect. To verify this, 35 elms were examined at random. They were classified according to their size and were rated as advanced, medium and backward, according to the degree of their advancement at the date of the observation, April 8, 1917. The results of the observations appear in Table II.

TABLE II

Circum. in Inches	Advanced		Medium		Backward	
	Infested	Uninfested	Infested	Uninfested	Infested	Uninfested
20 and up	1	3	0	0	0	0
10–20	1	1	1	1	2	0
5–10	1	3	2	2	2	2
Under 5	0	5	1	5	1	1
Total	3	12	4	8	5	3

It will be observed that the above seems to bear out this contention. In 1915 we observed a small elm, which had been set out the fall before, to be infested. It was presumably congenial to the insect because it was backward during that season. At any rate it has not been observed to be infested since that time.

Experiments with Cratægus

Many negative results in attempting to get aphids to establish on Cratægus led us to undertake some experiments with a view of determining to what extent this host was immune to the species. Young Cratægus seedlings were used in these tests. Five aphids were applied at a time and we tried to make 10 transfers, making a total of 50 aphids, to each seedling before placing it aside as immune. The aphids used were secured from infested Cratægus plants. The results of these tests appear in Table III.

It will be observed that the first four seedlings tested took colonies. In view of the difficulty of getting colonies to establish later in the season it would appear that the hardening of the tissues would be a condition which would bring about immunity. The seedlings used in experiments Ca–C17 to Ca–C23 inclusive had been used earlier in the season in the Aa–C series (Table IV), and in those tests were not acceptable to the aphids. They were subsequently cut back and watered with manure water until tender shoots were produced. Under these conditions two of the seedlings were acceptable to the Cratægus aphids.

TABLE III

Exp. No.	Duration of Experiment	Transfers		Results
		No.	Total Aphids Applied	
Ca-C1	7/2-10/15	1	5	Colony
Ca-C2	7/2-11/1	1	5	Colony
Ca-C3	7/2-8/5	6	30	Colony
Ca-C4	7/6-8/7	9	45	Colony
Ca-C5	7/18-8/1	9	45	None established
Ca-C6	7/18-8/1	10	50	None established
Ca-C7	7/18-8/1	10	50	None established
Ca-C8	7/18-7/21	2	10	Established
Ca-C9	7/18-7/21	3	15	None established
Ca-C10	7/18-8/1	10	50	None established
Ca-C11	7/18-8/1	10	50	None established
Ca-C12	8/1-8/17	12	60	None established
Ca-C13	8/1-8/17	9	45	None established
Ca-C14	8/1-8/17	11	55	None established
Ca-C15	8/1-8/17	9	45	None established
Ca-C16	8/1-8/17	9	45	None established
Ca-C17	8/3-9/14	6	30	None established
Ca-C18	8/3-8/15	1	5	One established
Ca-C19	8/3-9/14	12	60	None established
Ca-C20	8/3-8/15	1	5	Five established
Ca-C21	8/3-9/14	5	25	None established
Ca-C22	8/3-9/14	14	70	None established
Ca-C23	8/3-9/11	5	25	None established
Ca-C24	8/23-9/14	1	5	Colony
Ca-C25	8/23-9/14	2	10	None established
Ca-C26	8/23-9/14	7	35	None established

From these experiments and from our general experience with the species we conclude;

(1) That through being continuously subjected to the attacks of the woolly aphis Cratægus has acquired a strong immunity against this pest.

(2) That this immunity is inherent or it may be conditional, depending upon factors which influence the character of its growth.

Experiments in Transferring Cratægus Aphids to Apple and Vice Versa

As early as 1910 Hayhurst, thinking that there might be two races of *lanigera*, one on apple and one on Cratægus, made attempts to establish the Cratægus forms on apple and vice versa. His results were all negative. The writer repeated the experiments in 1911 with the same results and in 1913 Mr. Quick, a student assistant, made the same attempt and succeeded in getting a few Cratægus aphids to establish imperfectly on apple. In view of the immunity of most Cratægus seedlings at the time (in late summer), when all of these tests were made, the results were not surprising.

In 1917 Mr. William Lee, a student assistant working under the writer's direction, repeated the tests and included in his experiments Cratægus seedlings which he had previously found to be congenial to Cratægus aphids. His results are given in Table IV. Aa-C17 to

Aa–C23 inclusive were found to be congenial to Cratægus forms in the Ca–C tests (Table III). Under "remarks" is given the number of these seedlings in the Ca–C tests of Table III.

TABLE IV

Exp. No.	Duration of Experiment	Transfers		Results	Remarks
		No.	Total Aphids Applied		
Aa–C2	6/15–7/12	10	50	None established	....
Aa–C3	6/15–7/12	12	60	None established	....
Aa–C4	6/15–7/12	12	60	None established	....
Aa–C5	6/15–7/12	13	65	None established	....
Aa–C6	6/15–7/12	11	55	None established	....
Aa–C7	7/13–7/26	10	50	None established	....
Aa–C8	7/13–7/26	10	50	None established	....
Aa–C9	7/13–7/26	11	55	None established	....
Aa–C10	7/13–7/26	10	50	None established	....
Aa–C11	7/13–7/26	11	55	None established	....
Aa–C12	7/20–7/31	10	50	None established	....
Aa–C13	7/20–7/31	10	50	None established	....
Aa–C14	7/20–7/31	10	50	None established	....
Aa–C15	7/20–7/31	10	50	None established	....
Aa–C16	7/20–7/31	10	50	None established	....
Aa–C17	7/31–8/14	18	83	None established	Was Ca–C3
Aa–C18	8/6–8/23	4	20	Colony	Was Ca–C8
Aa–C19	8/15–9/14	13	65	None established	Was Ca–C18
Aa–C20	8/15–11/15	1	5	Colony	Was Ca–C20
Aa–C21	9/14–10/5	2	25	None established	Was Ca–C24
Aa–C22	10/5–10/13	1	20	None established	Was Ca–C25
Aa–C23	10/15–11/14	2	35	8 established	Was Ca–C1

It should be stated in the case of Aa–C23, which was Ca–C1 of Table III, that it was brought into the tests at a time when it was beginning to shed its leaves. Aphids established on it and produced young though the latter did not establish. When the latter were born practically all the leaves had been shed and the tissues are bound to have hardened.

Further trials were made by attempting to establish apterous viviparæ from Cratægus on apple with the results indicated in Table V.

TABLE V

Exp. No.	Duration of Experiment	Transfers		Results
		No.	Total Aphids Applied	
Ca–A1	7/16–9/14	18	88	None established
Ca–A2	8/2–9/14	12	60	None established
Ca–A3	8/2–11/1	13	65	Colony
Ca–A4	8/2–9/14	18	90	None established
Ca–A5	8/2–11/1	14	66	Colony
Ca–A6	10/15–11/1	2	3	None established

The apple seedlings used in the tests given in Table V were tested and found to be congenial to apple aphids.

The results of our transfer experiments lead us to the conclusion:

(1) That apterous viviparæ from apple can establish on Cratægus though they do not establish on that host as readily as they do on apple.

(2) That apterous viviparæ from Cratægus can establish on apple though they apparently do not establish as readily on that host as do the apterous viviparæ from apple.

Northern Spy Immunity

Aside from experiments undertaken with Northern Spy roots no definite experiments were undertaken to see to what extent different apple seedlings were immune to the woolly aphis. It might be stated however, from general experience, that we noticed a difference in the degree of immunity of different apple seedlings. Generally speaking, though, we had no difficulty in establishing either the offspring of spring migrants or of apterous viviparæ from other apple seedlings on this host.

In these tests pieces of Northern Spy root were placed in tin salve boxes and handled in the same manner as described for our experiments with the apple root forms. Five aphids were applied to each piece of root and when these had died another attempt was made to establish a colony by adding five more aphids. The aphids used were usually of the first instar and were taken from crab roots.

We made 161 attempts to establish colonies on Northern Spy roots, using a total of 805 aphids. Of the 161 attempts we got colonies to establish temporarily in 16 instances. In two of the trials we succeeded in getting the aphids to establish long enough to produce young but the latter failed to establish permanently. In no case did we succeed in getting permanent colonies to establish on Northern Spy roots.

As a check against these results we made 51 trials to establish aphids on crab roots, using in the tests 255 aphids. Twenty-seven of the trials yielded colonies. In most instances these colonies were permanent.

Most of these tests were made by my student assistants, Messrs. W. D. Merrill and Wm. M. Lee, and their notes repeatedly call attention to the sickly condition of the temporary colonies on Northern Spy as compared with the thrifty colonies on crab roots.

From these tests we conclude that Northern Spy is immune to the woolly aphis and that, when aphids do establish temporarily, it is due to the fact that they are exceptionally hardy rather than the fact that the host is congenial.

Experiments with Apple Root Forms

Experiments were begun with a view of working out the duration of the instars, number of young per female, longevity, number of generations per season, etc., of the apple root forms. We got satisfactory results by using tin salve boxes in the bottom of which we poured paraffin mixed with lamp black. This enabled us to detect aphids or exuviæ which had fallen on the bottom of the box. Pieces of root were wrapped at one end with moist cotton batting and the other end was left exposed for the aphids. The boxes were sunk in soil out of doors and were covered with a board.

Records of 40 aphids made by my predecessor, Mr. Paul Hayhurst, during March and April of 1910 are summarized in Table VI.

The days for each instar are given. Duration of the fifth instar is practically the same as the period of reproduction as aphids almost invariably begin to reproduce on the same day that they moult the fourth time. The number of days from birth to the first young will therefore generally be the same as the combined number of days of the first four instars. The age at death is expressed in days.

Table VI

	Days 1st Instar	Days 2nd Instar	Days 3rd Instar	Days 4th Instar	Days 5th Instar	Days to Young	Max. Yng. per Day	Total Young	Age at Death
Average	7.3	3.9	3.2	3.8	22.6	18.8	11.5	86.3	40.2
Range	3–14	2–7	1–6	1–8	5–47	15–25	2–23	8–167	21–59

If the aphids develop on the roots of apple under normal conditions as well as in the salve boxes and if later generations develop as rapidly as the generations in March and April, it would appear that it would be possible for 6 to 12 generations to develop from March to November, which period is the period of activity of the root forms in this latitude.

Experiments with Fall Migrants

In 1915, 1916 and 1917 we made numerous attempts to get fall migrants to deposit sexupariæ on Cratægus, apple and elm seedlings under cage conditions. Migrants were placed in cages of varying sizes with these seedlings and with large limbs from elms but we failed to get the sexed forms in 1915 and 1916. During the same period we also tried placing seedlings of its three hosts in the window and releasing the migrants in a dark corner of the laboratory. Although the migrants made their way to the seedlings they failed to deposit young on them. In 1917 we succeeded in getting migrants to deposit the sexed forms by confining them in large vials and under glass cylinders with rough pieces of elm bark, however, we failed to get any eggs from the sexed forms,

Eriosoma cratægi Oestlund

Mounts were made of the fall migrants of *Eriosoma lanigera* secured from different sources (apple and Cratægus), with a view of determining the effect of the host on the antennæ of the aphids. The results are tabulated in Table VII. The table gives the measurements of the segments in mm. The number of annulations of the segments is also given.

The following explanation is given for the slide numbers.

Slide 1.—From control colony on apple reared from a spring migrant in 1917.

Slide 2.—From a control colony on Cratægus reared from a spring migrant in 1915.

Slides 3 and 4.—From colonies on potted apple trees which were presumably started by spring migrants in 1917.

Slide 5.—From the same source as Slide 2.

Slide 6.—From apple colony established by transferring apterous viviparæ from Cratægus in 1917. (Colony Ca-A5 of Table V.)

Slides 7 to 11 inclusive.—From Cratægus colonies established by transferring apterous viviparæ from apple in 1917. (Colonies Aa-C18 and Aa-C20 of Table IV.)

Table VII

Slide No.	I	II	III		IV		V		VI	
	Meas. in mm.	Meas. in mm.	Meas. in mm.	An. No.	Meas. in mm.	An. No.	Meas. in mm.	An. No.	Meas. in mm.	An. No.
1	.068	.073	.416	22	.124	5	.124	7	.088	0
1	.061	.065	.415	26	.112	6	.112	6	.084	0
2	.061	.064	.432	27	.124	5	.146	8	.085	1
3	.059	.056	.320	16	.108	4	.112	5	.085	2
3	....	.064	.335	18	.072	3	.120	5	.092	1
3	.064	.064	.382	20	.130	7	.126	6	.096	2
3	....	....	.365	20	.131	6	.128	5	.092	0
4	.056	.064	.400	21	.112	4	.128	7	.088	0
4	....	.064	.400	20	.128	5	.120	5	.096	1
4	.058	.066	.365	18	.112	5	.115	5	.086	0
5	.059	.060	.455	28	.120	6	.141	7	.096	2
5	.064	.064	.440	27	.112	6	.120	7	.104	2
5	....	.056	.462	29	.120	6	.144	8	.112	2
6	....	.051	.342	20	.096	3	.110	5	.090	1
6	.056	.053	.343	20	.120	4	.123	6	.072	1
6	.051	.061	.343	18	.110	3	.123	6	.083	1
6	....	....	....	..	.088	3	.100	5	.075	2
7	....	.056	.375	24	.120	5	.128	6	.112	3
8	.051	.051	.400	24	.120	7	.131	7	.112	4
8	....	....	.420	25	.131	6	.152	10	.115	3
8	....	....	....	..	.112	5	.152	8	.115	5
9	....	.064	.368	..	.112	7	.148	8	.112	3
9	.064	.064	.405	27	.112	7	.156	8	.112	3
9	.064	.061	.420	27	.135	7	.152	8	.112	4
9	.064	.061	.430	28	.128	7	.152	10	.112	3
10	....	.061	.431	27	.128	6	.160	7	.115	3
10	....	.064	.430	25	.135	7	.160	8	.118	3
11	.056	.056	.430	25	.120	6	.155	8	.096	2
11	....	.056	.440	28	.128	6	.148	9	.112	2

It appears from a study of the 13 antennæ of apple migrants and the 16 antennæ of Cratægus migrants that the antennæ of the latter are usually longer than those of the apple migrants. Especially is this the case in segments III, V and VI. For convenience the writer has

averaged the antennæ of migrants of the two hosts separately and collectively in Table VIII. The wide range of variation in the antennæ of *Eriosoma lanigera* is well shown in the range for the 29 antennæ measured. It is such that it might well embrace the measurements given for *Eriosoma cratægi* by Davis in Volume 3, No. 5 of this JOURNAL.

TABLE VIII

	I	II	III		IV		V		VI	
	Meas. in mm.	Meas. in mm.	Meas. in mm.	An. No.	Meas. in mm.	An. No.	Meas. in mm.	An. No.	Meas. in mm.	An. No.
Thirteen Antennæ from Apple Migrants										
Average......	.059	.062	.369	20	.111	4	.119	6	.087	1
Minimum.....	.051	.051	.320	16	.088*	3	100	5	.072	0
Maximum....	.068	.073	.416	22	.131	7	.128	7	.096	2
Sixteen Antennæ from Cratægus Migrants										
Average......	.060	.060	.423	27	.122	6	.147	8	.109	3
Minimum.....	.051	.051	.368	24	.112	5	.120	6	.085	0
Maximum....	.064	.064	.462	29	.135	7	.160	10	.118	5
Thirteen Antennæ from Apple and Sixteen Antennæ from Cratægus Migrants										
Average......	.060	.061	.389	23	.117	5	.134	7	.099	2
Minimum.....	.051	.051	.320	16	.088*	3	.100	5	.072	0
Maximum....	.068	.073	.462	29	.135	7	.160	10	.118	5

*The smallest segment IV was on slide 3. It measured .072 but appeared somewhat abnormal.

EXPLANATION OF PLATE 6

1 and 2. Antennæ from migrants out of control colony on apple established from the offspring of a spring migrant.

3. Antenna from fall migrant taken from colony on potted apple tree.

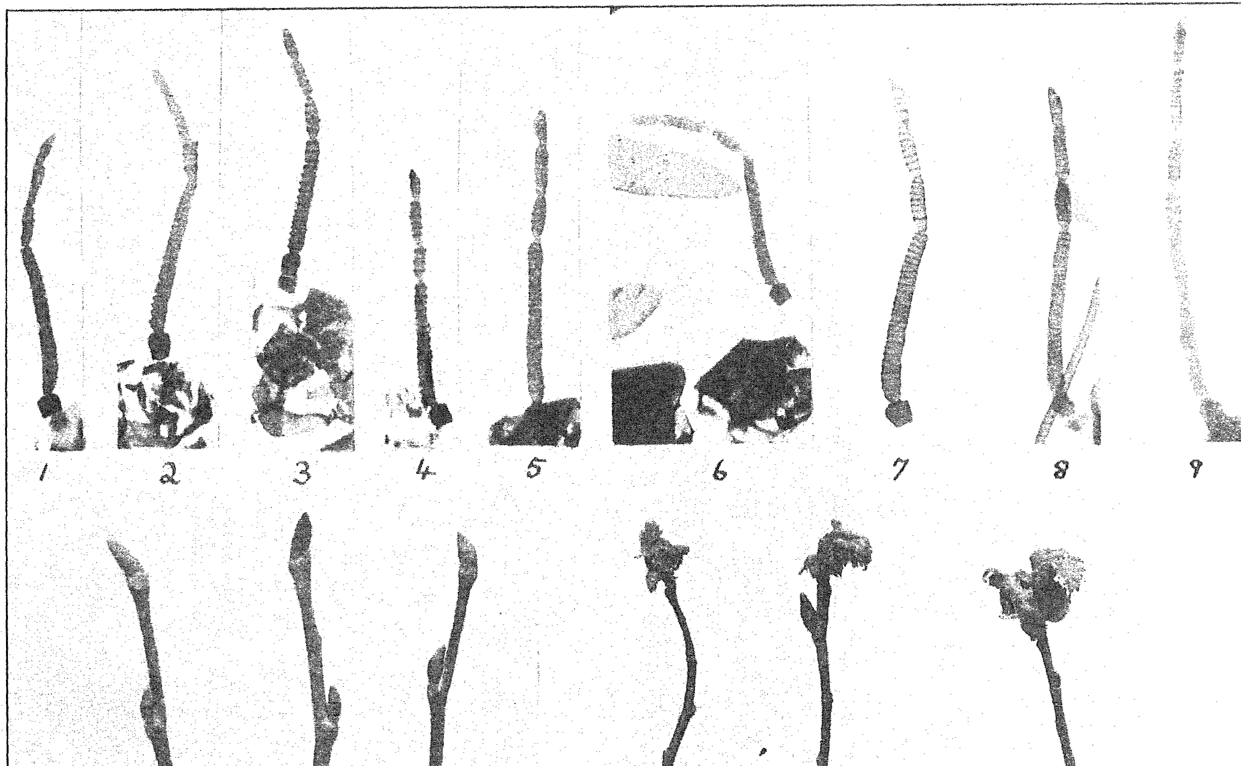
4. Antenna from fall migrant out of colony established on apple with apterous viviparæ from Cratægus. (Colony Ca–A5 of Table V.)

5. Antenna from fall migrant out of control colony established on Cratægus from spring migrant.

6–8 inclusive. Antennæ from fall migrants out of colonies established on Cratægus with apterous viviparæ from apple. (Colonies Aa–C18 and Aa–C20 of Table VI.)

9. Antenna of fall migrant of *Eriosoma cratægi* taken from mount loaned me by A. C. Baker.

The two lower pictures represent normal and infested elm buds collected at the same time, April 6, 1917 and from the same tree.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Baker,[1] in suggesting that *Eriosoma cratægi* is a synonym of *Eriosoma lanigera*, pointed out that the principal difference between the species was in segments V and VI which were proportionately longer in the former species. As previously indicated, our data show that these two segments are proportionately longer in our Cratægus reared aphids.

Through the courtesy of Mr. Baker the writer was permitted to examine a mount of *cratægi* migrants. A photograph was taken of a typical antenna of this species and photographs of *lanigera* migrants were made in comparison. All are taken at the same magnification (about 48 X), and are represented in the accompanying plate. It will be noticed that Nos. 5 and 8, antennæ from Cratægus reared aphids, are strikingly similar to the antenna of *cratægi*, figured in 9.

If measurements and structural differences are to be used as a basis for dividing them, it would hardly be possible for us to regard *cratægi* and *lanigera* as two species.

Conclusions

(1) The life-history of *Eriosoma lanigera* in the Ozarks is the same as recorded for Maine and for Vienna, Va., with the exception that there are probably more than two generations of apterous viviparæ on apple and Cratægus.

(2) Experiments with apple root forms indicate that there may be from six to twelve generations a year in the Ozarks.

(3) Elms have acquired a strong degree of immunity against this species. Susceptibility to attack seems to be correlated with backwardness of growth in the spring.

(4) *Cratægus crus galli* is largely immune to the insect, the condition of immunity being apparently inherent in some instances and conditional in others.

(5) Northern Spy stock is immune to the species.

(6) Apterous viviparæ from Cratægus will establish on apple and apterous viviparæ from apple will establish on Cratægus though the Cratægus individuals do not establish as readily on apple as do the individuals from the same host.

(7) Based on a study of the antennæ, the writer's data indicate that *Eriosoma cratægi* Oestlund is a synonym of *Eriosoma lanigera* Hausmann.

[1] Report No. 101, U. S. Department of Agriculture, Office of the Secretary, 1915.

THE CHIGGER-MITES AFFECTING MAN AND DOMESTIC ANIMALS

By H. E. Ewing and Albert Hartzell, *Ames, Iowa*

Although the chigger-mites are widely known over the world on account of their attacks on man and domestic animals, yet, because of their minute size, they have been remarkably exempt from thorough investigations which usually have been applied to pests of so much economic importance. In Europe, due chiefly to the work of Dr. Oudemans and to Berlese, we have recently learned much of the taxonomy, biology, habits, and distribution of the foreign chigger-mites.

As is well known among entomologists, chigger-mites are the larvæ of the brilliantly colored harvest mites, which, according to acarologists, are placed in the family Trombidiidæ. This fact, however, was not known when many of our common chiggers were first described, or if known was not heeded. When these early descriptions were made, the larval characters of real taxonomic importance had not been worked out, so that these descriptions have proved to be all but valueless to us today, notwithstanding we now have an excellent key to the chiggers based on larval characters.

In this paper it has been the object of the writers to give a summary of the important biological and other facts concerning the chigger-mites known to affect man and domestic animals, together with references to a few important species found in this country which so far have not been recorded from these hosts. To the recorded observations of others we will add what we have learned of our American chiggers. Some of the species here mentioned have not been sufficiently known in the past to have acquired common or popular names, hence one of our chief tasks has been to get appropriate common names for these less known chigger-mites.

The Summer Chigger of Europe

[*Metathrombium poriceps* (Oudemans)] (Fig. 10*a*)

Chigger-mites have been studied more in Europe than in America, and it is now known that at least three different species are concerned in the attacks upon man and domestic animals. Of these three species, two are quite common, one attacking in the summer time, the other in the fall.

The summer chigger-mite of Europe is a very small creature not more than 0.4 mm. in length when unengorged. It is egg-shaped, and has above on the thorax two porous chitinous plates or shields.

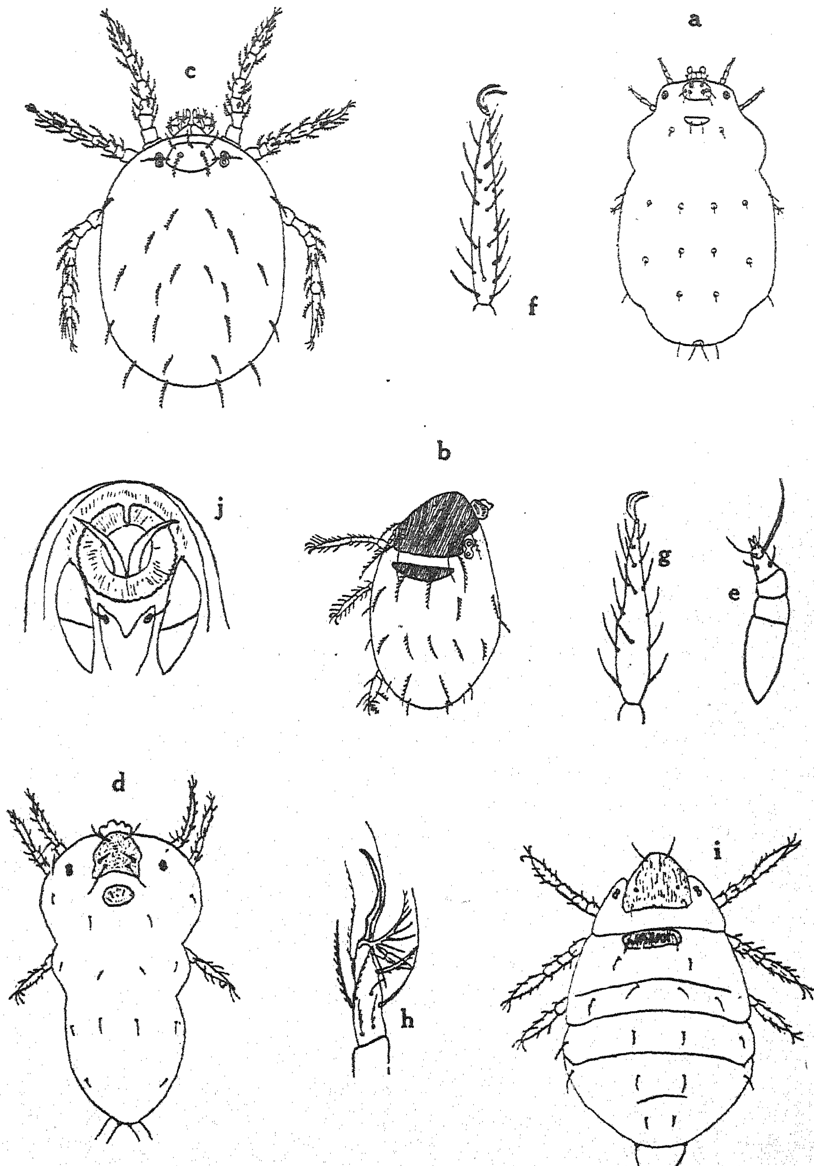

Fig. 10. Some of the more important chigger-mites. *A*, *Metathrombidium poriceps* (Oudemans), dorsal view; *b*, *Thrombidium striaticeps* Oudemans, dorsal view; *c*, *Microthrombidium tlalzahuatl* (Murray), dorsal view; *d*, *Euthrombidium trigonum* Hermann, dorsal view; *e*, right palpus from above; *f*, tarsus I of left leg; *g*, tarsus II of left leg; *h*, tarsus III of right leg; *i*, *Thrombidium muscarum* Riley, dorsal view; *j*, ventral view of mouth-parts. Figures *a*, *b*, *c*, and *d* after Oudemans. Remaining figures drawn from nature by Hartzell.

This chigger has been frequently reported from man. It also has been taken from the dog, and from chickens. Among the invertebrate hosts we find the house-fly (*Musca domestica*), many small dipterous insects as well as insects belonging to the following orders: Orthoptera, Ryhnchota, Diptera, Coleoptera, Lepidoptera and Hymenoptera. It has been recorded from spiders, from rodents, and from various mammals. This mite has been collected during the months of June, July, August and September. It is found in the Netherlands, France and Germany; and doubtless occurs in other parts of Europe.

The European Autumnal Chigger

[*Microthrombidium pusillum* Hermann]

It is the autumnal chigger-mite that has become noted because of its attacks on man and beast in Europe. This chigger-mite was long known under the name of *Leptus autumnalis*, and gave rise to a severe rash or itch which was called "erythema autumnale."

When unengorged these chiggers are very minute, being scarcely visible to the naked eye. They are brick red in color, and have above one dorsal median shield, which is trapezoidal in shape.

It was for a long while believed that this mite, as well as chiggers generally, lived on the juices of plants and that only under certain conditions did it become blood thirsty. C. V. Riley shared this belief with others, and stated as follows in regard to one of our American chiggers: "I have stated my belief that its normal food must, apparently, consist of the juices of plants and that 'the love of blood proves ruinous to those individuals who get a chance to indulge it.'"

The belief that chigger-mites lived normally on the juices of plants gained credence no doubt largely on account of Claparede's contention that they belonged to *Tetranychus*, a genus composed of plant-feeding acarids.

This chigger, like all other species of its genus, lives normally upon invertebrate hosts, especially insects, and is an accidental parasite only on higher animals. Besides being especially severe when on man, it is troublesome to horses, cattle, sheep, rabbits, dogs, and cats. When first attacking they attach themselves by means of their claws and palpi. Around the attached chigger, swellings are said to develop which may be as large as a pea or larger, and there is severe itching. It has been stated that fevers result at times after mite attacks, hence it is believed by some that this species, as well as others, gives off a toxin. This chigger has been reported for the months of September, October, and November.

Various insects are reported as being hosts for this mite, and are probably the normal ones. Among the other hosts reported are dif-

ferent birds and mammals. Oudemans has compiled a list of fourteen determined host species. To this should be added a larger list of hosts that were only determined to the genus or family. The species is reported from England, France, Belgium, Holland, and Germany.

The Striated European Chigger

[*Thrombidium striaticeps* Oudemans] (Fig. 10*b*)

There is another chigger-mite of Europe known to attack man and domestic animals. It does not appear to be as common or as important a pest as the two just considered. This chigger has parallel striations on the dorsal shields or plates. The larvæ are egg-shaped, and when somewhat swollen with blood are about 0.5 mm. in length.

This chigger has been found on man, the dog, the cat, and the domestic fowl. Its normal hosts are for the most part dipterous species. It has been reported from France, Belgium, and Holland.

The Kedani Mite

[*Microthrombidium* sp.]

In certain parts of Japan there is a chigger-mite that has been associated with a fatal disease known as river fever or flood fever. Tanaka, especially, insists that there is a connection between these mites and this disease. It appears that the mites by their attacks produce lesions which become points of entrance for certain bacteria which are the real cause of the fever. At the point of attack there is a papule which becomes surrounded by an inflamed area. This is followed by a pustule which gives way to a black scab.

The mites concerned are orange-red, and measure about 0.2 mm. in length when not engorged. The palpi are strong and single clawed. The legs are stout, and each is provided with three tarsal claws, the middle one being longer than the rest. The femora are divided. Above, the body is clothed with about thirty long doubly pectinate hairs.

The kedani mite appears to be a *Microthrombidium* species according to Tanaka's figure. Yet he does not show some of the more important taxonomic characters. The adult form is unknown.

The Ceram Chigger

[*Microthrombidium wichmanni* (Oudemans)]

Two chigger-mites are found in the East Indies that according to the various but authentic reports of different travelers must cause a scourge which is far more severe than any caused by the species of the temperate zones. One of these mites, it appears, is the species

which Wallace mentions in his work on the Malay Archipelago as causing him to come down with a serious disease while on his first visit to Ceram. For this reason we shall call this species the Ceram chigger.

In this species there is a single median shield present without crista. There is only one pair of psudostigmata. The tarsi have two thick and one thinner and longer claw. Two eyes are present.

Oudemans states that this species was collected in New Guinea in separate lots on the head of *Goura* sp., where they had fastened themselves to the skin by the hundreds in regular rows, like paving stones. They had caused the feathers to fall from the infested region.

Alfred Russel Wallace gives his experiences with a species in Ceram which it appears is the one under consideration. He states: "All the time I had been in Ceram I had suffered much from the irritating bites of an invisible acarus, which is worse than mosquitoes, ants and every other pest, because it is impossible to guard against them. This last journey in the forest left me covered from head to foot with inflamed lumps, which after my return to Amboyna, produced a serious disease, confining me to the house for nearly two months."

Besides being found on man, this chigger has been recorded from *Goura coronata.* Authentic records of the species are from New Guinea and the Celebes. In addition we have Wallace's report from Ceram which probably concerns this species.

The East Indian Shrub Chigger

[*Schöngastia vandersandei* (Oudemans)]

In this country the chigger-mites are found almost entirely in the grass, even short grass at times harboring them. In New Guinea there is a chigger that climbs shrubs and bushes where it is brushed upon the bodies of larger animals as they pass by.

It is a bright red chigger with a single, trapezoidal, dorsal shield. The coxæ each have one hair. The dorsal shield is convex behind; palpal claws two or three partate. Mandibles claw-like, long, straight and toothed.

This species causes a disease known in New Guinea as shrub-itch. Wayfarers brush the almost invisible mites onto their bodies from the low hanging branches of trees or from shrubs. The mites are said to get under the skin, and to cause a terrible irritation. Besides occurring on man, the shrub-chigger has been found on *Goura coronata.* It is common in New Guinea, and probably occurs in neighboring islands.

The Mexican Chigger-Mite

[*Microthrombidium tlalzahuatl* (Murray)] (Fig. 10*c*)

The Mexican chigger mite has been known to entomologists through our scientific literature for half a century, and due to the efforts of Oudemans we now have most excellent figures of it. This mite was originally described by Murray in his well-known volume on "Economic Entomology—Aptera" although it was mentioned earlier by Lemaire who has given us an account of its accidental introduction into France at an early date.

The larvæ are a bright yellow orange, and the body is oval in shape, being evenly rounded at either end. There is a single shield above; and the rather conspicuous palpi each end in a bifurcate claw.

This mite is said to occur in the more temperate parts of Mexico, and is not found in the hot dry regions. It attacks the eyelids and armpits especially and apparently through predilection. The Indians, it is stated, remove these chiggers by means of a fine grass stalk when a needle is not obtainable.

The natural hosts of the mite have not been determined, and we have no record of it attacking other mammals than man, but it very probably does. Osborn has suggested that this species may be distributed over parts of the Southern States. The chiggers which the senior writer has so often encountered in Mississippi do not attach at the eyelids or armpits, but about the ankles and calves of the legs.

The American Chigger-Mite

[Genus? Species?]

We have at least two species of chiggers in the upper Mississippi Valley which attack man. This was shown by no other than C. V. Riley who obtained his original material from the superficial anatomy of one, Otto Lugger,—well-known American entomologist. Riley described one of these species under the name of *Leptus americanus* and the other under the name of *Leptus irritans*, and gave figures of each. The figures of Riley's have been copied many times, and are familiar to most of you present at this meeting. It is almost lamentable that from them one can get hardly a character which is used today in specific diagnosis of chigger-mites. As the two mites were not reared we are left in doubt to this day as to their identity.

Riley's *Leptus americanus* was a very small chigger for he states: "This species is barely visible to the naked eye. . . ." It has a slender body, rounded behind and pointed in front. The legs were very long and slender. Although the present writers have observed many harvest mite larvæ in Iowa, we have failed to find any liable

to attack man, which look similar to Riley's drawing of his *Leptus americanus*.

Riley states that this mite infests chiefly the scalp and armpits, that it does not bury itself in the flesh, but simply insinuates the anterior part of its body under the skin. The method of attack given by Riley at once suggests the Mexican chigger, but if you will compare Riley's figure with Oudeman's drawing of the Mexican chigger you can see at once that they are different species. The Mexican chigger is a broad, stout species, with moderate legs, while Riley's drawing of *americanus* shows the legs longer than the body. We know nothing of the natural hosts of the mite or if its distribution other than that it is found in the upper Mississippi Valley.

The Irritating Chigger-Mite

[Genus? Species?]

This species, which has long gone under the name of *Leptus irritans* Riley, has been most frequently mentioned in our American literature. Riley says of it: "This is the most troublesome and perhaps best known of the two (the other species being his *Leptus americanus*) causing intense irritation and swelling on all parts of the body. . . ." We have made many attempts to place this species of Riley's but have failed. It can not be placed even in the proper genus, as we recognize the genera of Trombidiidæ today.

The irritating chigger according to Riley's figure and description is of minute size, but has a broad body and very large palpi. Indeed the palpi, as shown in Riley's figure, are larger in proportion to the body than in any of our known species.

Since Riley, as well as others, speaks of this chigger as being so common and so troublesome it may be thought by some that it is no other than our common locust chigger so frequently found on the wings of grasshoppers in the upper Mississippi Valley. This point has been tested here at Ames by letting these locust chiggers crawl over the bare arms and legs without effect. Individuals have gone through grass heavily infested with these locust chiggers with the trousers rolled up at the bottom and with the socks rolled down at the top, but without a single attachment. Many men have been observed working in areas infested with these chiggers, but they have not complained of being attacked. Just what species Riley's *irritans* will prove to be we cannot say. It very probably will never be known for a certainty.

The Locust Mite

[*Euthrombidium trigonum* (Hermann)] (Fig. 10*d*, *e*, *f*, *g*, and *h*)

The larvæ of this species were first reported from Omaha, Nebraska,

by Riley, in 1868, on the Rocky Mountain locust. The following year it was reported from Oregon and Missouri. In May, 1874, the adult was observed attacking the eggs of the Rocky Mountain locust in northwestern Iowa. It was recognized by Riley as *Trombidium sericeum* Say. At that time the immature stages of the TROMBIDIIDÆ were unknown. In the same report he recognized the larval form, of what afterwards proved to be the same species as the above, as *Astoma gryllaria* LeBaron. Riley was the first to work out the life-history of the locust mite. In 1878 he published a description of it as a new species under the name *Trombidium locustarium*. Banks, however, considers it a synonymn of *Astoma locustarium* Walsh. In 1912 the senior writer sent an adult locust mite to Berlese, who determined it as *Euthrōmbidium locustarium* Walsh. A larva of the same species, taken from *Melanoplus differentalis*, was sent to Dr. Oudemans, who recognized it as nothing less than the European *Euthrombidium trigonum* Hermann. Since Oudemans based his determination on larval characters, which in this group are more definite than adult characters, we believe it to be correct. Furthermore, we have carefully compared Oudeman's and Berlese's descriptions and figures with our own material of this species and conclude that *Euthrombidium locustarium* Walsh is synonymous with *Euthrombidium trigonum* Hermann.

The larvæ of the locust mite may be distinguished from the other members of the genus by the bifurcate coxal spurs and the four hyaline lobes on the cephalic border of the front dorsal shield.

Riley was first to study the biology of this species. The senior writer has also carried on life-history experiments with this mite, and succeeded in rearing an adult from a larva infesting *Melanoplus bivittatus*. The adults showed a decided preference for grasshopper eggs. In no case could the mites be induced to attach themselves to man. It is also of interest to note that this mite has never been reported from man or domestic animals in Europe.

As far as is known the hosts of the locust mite are confined to four families of Orthoptera, namely: ACRIDIIDÆ, LOCUSTIDÆ, GRYLLIDÆ and MANTIDÆ. It has been found on the following species of grasshoppers in this country: *Melanoplus differentialis, M. spretus, M. augustipennis, Spharagemon bolli, Schistocerca americana.*

Euthrombidium trigonum is generally distributed throughout Minnesota, South Dakota, Iowa and Illinois. It has been reported from Nebraska, Kansas, Missouri and Oregon. It has also been found in Germany and Holland.

The House-fly Chigger

[*Thrombidium muscarum* Riley] (Fig. 10 *i, j*)

The larvae of this species were recognized by Riley, in 1875, as *Astoma parasiticum* Latreille. Two years later a description of it was published in the Report of the United States Entomological Commission as a new species under the name *Trombidium muscarum* Riley. We have carefully examined the larva of his form and believe that the species is valid, and should be retained in the genus *Thrombidium*. This genus may be distinguished by the presence of two median dorsal shields. The front shield is furnished with eight setæ and has longitudinal striations.

During some seasons scarcely a house-fly can be found that is not infested with a number of these mites. Riley succeeded in rearing the adult. The senior writer has also reared the adult of this species.

As far as known this mite is confined to a single host, *Musca domestica*. It could never be induced to attach to man. Apparently this chigger is generally distributed throughout the United States. We have records from New York, Illinois and Iowa.

Summary

1. Six separate and distinct species of chigger-mites taken from man and domestic animals have been accurately described, figured and named. Three of these are found in Europe, two in the East Indies and one in Mexico.

2. At least two distinct chigger-mites are known to attack man in this country. We have been unable to place either one of these species in our modern classification of the chigger-mites, and are in doubt in regard to their specific identity.

3. The common locust mite in the United States is the same as the common locust mite of Europe, hence *Trombidium locustarium* Walsh is a synonym of *Euthrombidium trigonum* (Hermann) of the old world. Observations and experiments have shown that this species does not attack man.

4. The scientific name of our house-fly chigger, *Thrombidium muscarum* Riley, still stands, the species being good.

5. Only two species of our American chigger-mites have been reared to maturity.

6. A thorough survey of our chigger-mite fauna, with notes on hosts and geographical distribution is most needed at present.

FERTILIZATION OF QUEEN BEES

By C. W. Howard and L. V. France, *University Farm, St. Paul, Minn.*

The possibility of controlling the fertilization of queen bees has been in the minds of beekeepers for many years. From time to time it has been brought about under artificial conditions, the life of the queen being thereafter perfectly normal and in accordance with that of one fertilized by a male in the usual manner. Several stories have come to the writers stating that the queen could be taken at the time she was leaving the hive, held between the fingers of one hand while the organs of a mature drone were pressed out with the fingers of the other and the mass of spermatic fluid which exuded dropped into the open extremity of the queen. Fertilization took place in an apparently normal manner and the queen was accepted by her colony and remained alive one or two seasons producing worker brood in large quantity. In the reports of the U. S. Department of Agriculture for 1885 and 1886 and of the U. S. Commissioner of Agriculture for 1887 are reports of various methods adopted in attempts to artificially fertilize queen bees. A large number of successes were claimed. The method followed was that described above and queens from one to fifteen days old were used. In the *American Bee Journal* in November, 1878, appeared a third report by Mr. J. Hasbrouck, in which he claimed to be able to cause queens and drones to mate when confined in small glass boxes.

This work done between 1885 and 1887 seems to have been discredited. The possibility of accomplishing this feat was again broached by Professor Francis Jager in 1914 and the senior author was asked to coöperate in the work. In the number of *Science* for November 13, 1914, a preliminary report upon a successful case of artificial fertilization was published. Since that time the writers have attempted to successfully repeat the experiment, but have almost uniformly failed. The advantages, both to the practical beekeeper and the student of genetics, if this could be done are obvious and need not be detailed here.

The queen bee reported on in *Science* in 1914 wintered in good condition, but soon after removal to the open in the following spring she began to lay drone eggs as well as worker eggs and finally produced exclusively drone eggs. After this had continued for three weeks she was killed and the contents of the spermatheca examined. It was packed with live active spermatozoa, showing conclusively that fertilization had taken place. If left alive she would have probably soon resumed the production of worker eggs.

During the summers of 1915 and 1916, 55 duplicates of this experi-

ment were carried out, making a total of 63 experiments. Of these, aside from the one already recorded, three were partial successes, the remainder were failures. Twenty-six queens died or were killed by the workers a few days after they were fertilized and before sufficient time elapsed to allow of egg production. The remainder laid eggs in sufficiently large quantity to ascertain the sex of the progeny or else the queens were killed and opened, after a few drone eggs had been laid, and the spermatheca found to contain no spermatozoa.

The method followed in the operation was as follows: Being unable to secure successful manipulation by squeezing out the drone organs and allowing the spermatic fluid to drop into the posterior chamber of the female, we carefully dissected out the seminal vesicles of mature drones, using sterile instruments to mix the contents with a drop of sterile salt solution (0.75 gr. to 100 cc. H_2O). In the later trials the salt solution was not used, its purpose being merely to dilute the spermatic fluid for greater facility in handling. During cool weather the instruments were kept warm. If the spermatozoa were inactive the material was discarded and a new preparation made. The queen was held loosely between the fingers of the left hand, the posterior end upward. With the right hand a capillary tube into which the spermatic fluid had been drawn was then inserted into the bursa copulatrix of the queen and the contents gently forced into the vagina by pressure from the mouth. The queen was then placed in a queenless colony and left under normal conditions, except that a queen excluder was applied to the hive next to the bottomboard.

To prevent the possibility of natural fertilization each queen was taken as soon as she emerged from the queen cell and one or both pairs of wings clipped off. All drones were removed from the hives and a queen excluder kept on. Queens were taken at all ages, varying from two to thirty-five days, although the majority were treated at the age of six to seven days. During 1916 practically all the queens were fertilized at the time when they were trying to leave the hive, apparently for the marriage flight.

Only mature drones were used. Careful observations showed us that drones were mature and spermatozoa active when they were five to six days old, but most of those used were ten days or more of age and had had several flights.

Where queens laid eggs from eleven to forty days intervened between the attempted fertilization and egg laying, with an average of twenty days. During 1916 whenever a queen attempted to escape from the hive for a flight she was refertilized. In this way some were operated upon two to three times, but still with no results.

The three partial successes were as follows: One thirteen-day-old

queen was fertilized after the method described. After an interval of twenty-six days, although the abdomen was enlarged, no eggs had been laid and the female appeared sick. She was killed and the spermatheca examined. It was found quite full of spermatozoa. The second case was that of a queen whose age was not known at the time of fertilization. Seven days later she was found in the queen trap trying to escape from the hive and was refertilized. Several of her eggs produced worker larvæ and five eggs were placed in queen cells. All of these were capped over, but robbers destroyed the colony preventing complete observations. A third case was a six-day-old queen which after an interval of forty days began to produce eggs, about 5 per cent of which produced worker bees and the remainder drones. During the interval between the first attempted fertilization and egg laying she three times tried to escape from the hive and each time was refertilized. It was only after the last attempt that her abdomen began to enlarge and she prepared for oviposition.

If this operation can be done once it would seem that we ought to be able to repeat it with successful results. This led to a closer examination of the female organs. Our observations agree with those of other investigators as to the existence of the S-shaped bend and muscular pump in the spermathecal duct. This probably prevents the forcing of the spermatic fluid into the spermatheca. There is undoubtedly a time or a natural stimulus which causes this valve to open and if the operation can be performed at this time the fluids will enter. The problem is to find when this takes place. So far we have been unable to determine this point.

Our results would indicate that if the mating of queen bees is to be controlled it must be done in some other way than the one followed by us.

On account of the presence in some of the North Atlantic States of *Laspeyresia molesta* Busck, a serious pest of deciduous fruits, a conference was held Monday, March 18, in the office of Dr. A. L. Quaintance, Bureau of Entomology, Washington, D. C. The following were in attendance: Prof. W. J. Schoene, Blacksburg, Va.; L. M. Peairs, Morgantown, W. Va.; Prof. E. N. Cory, Dr. Philip Garman, College Park, Md.; Prof. C. A. McCue, Newark, Mr. Wesley Webb, Dover, Del; Dr. T. J. Headlee, New Brunswick, N. J.; Dr. W. E. Britton, New Haven, Conn.; Dr. A. L. Quaintance and Messrs. Whitcomb and Wood of the Bureau of Entomology.

Scientific Notes

On the Life-History of Sarcophaga eleodis Aldrich. On September 13, 1916, the writer was collecting material for study of the life-history of several species of Eleodes at a point some five miles northwest of Maxwell, New Mexico. The adults were quite numerous at this time (about 3.30 p. m.) along the roadsides and, because of the scant vegetation, could be seen for some distance, particularly from horse back.

A specimen of *Eleodes obsoleta* was about to be picked up when an adult Sarcophagid was observed closely following the beetle, about an inch behind. The beetle was watched for nearly fifteen minutes during which time it traveled at least eight feet, being constantly in motion and followed persistently by the fly.

Finally the beetle reached the main stem of a Russian thistle and rested. The fly immediately mounted its back, facing in the same direction, and remained there for about four minutes while it larviposited on the posterior tip of the left wing cover. The beetle remained quiet for about two minutes longer, when it moved the tip of the abdomen, thereby exposing the anus. At once the larva became active and, in the merest fraction of a second, had disappeared within the body of the beetle through the anus.

The beetle thus attacked lived for thirteen days, dying on September 26, and on the 28th the full-grown larva issued, breaking off the head of the host in doing so. On March 12 the larva had entered the pupa stage, from which the adult fly emerged on April 3, 1917.

Geo. W. Barber,
Scientific Assistant, Bureau of Entomology,
U. S. Department of Agriculture

Brown-tail Moths Taken on Importations. While inspecting a large importation of nursery stock, during the first week in February, I took a complete nest of the brown-tail moth (*Euproctis chrysorrhoea* Linn.) on European mountain ash (*Sorbus aucuparia*). Within the nest of silk and leaves was a large number of live hibernating caterpillars. Had this nest of one of our most destructive imported pests been permitted to remain on the host tree and planted in the extensive nursery in the spring, we would have had another infestation in a short time to rival the most serious one now in New England states. This latter infestation is the cause of hundreds of thousands of dollars' damage each year to the trees and property valuation within the infested area.

In view of this we should use every precaution to prevent another infestation by having all importations closely inspected by thoroughly trained men or still better have Congress realize the importance of passing a quarantine law which would prevent the importation of all nursery stock which carry destructive pests. This latter plan cannot be over-emphasized to our Senators and Representatives in Washington at present. We can no longer afford to lose such extensive and increasing amounts of property each year due to the rising number of imported insect pests and plant diseases.

During the European conflict foreign inspection of nursery stock is likely to be somewhat imperfect, so we must as protectors, give more careful attention to all horticultural importations.

T. M. Trimble, *Dep. Nursery Inspector,*
Bureau of Economic Zoölogy,
Primos, Delaware Co., Pa.

Molasses Sprays for the Control of Monarthropalpus buxi Labou.[1] On May 25, 1915, molasses sprays for the control of the boxwood midge were applied to a hedge in Baltimore at 6 p. m. Two strengths, one pound and four pounds to fifty gallons of water were used. Examination at 8 a. m. showed large numbers of the adults entrapped in the spray on the surface of the leaves. The greater number were caught in the spray containing four pounds of molasses. The sprays were applied too late to reach the maximum number of adults in flight as the maximum emergence occurs from May 10 to 15. It was planned to spray the entire hedge the following spring but during the winter the hedge was cut down and it was found impossible to continue the tests. The preliminary results are, therefore, offered in the hope that others may be able to test this control measure more extensively.

E. N. Cory.

Notes on a Spirea Leaf-roller. *Olethreutes hemidesma* Zeller is not generally recognized as being of any particular economic importance. Arthur Gibson (36th Rep. Ent. Soc. Ont. 119) has mentioned its abundance at Ottawa, Ontario, Canada, and J. J. Davis (Journ. Econ. Ent. 3–185) has reported its injury to Spirea Van Houtii in Illinois. These two records seem to be the only references in the economic literature.

In July, 1916, these leaf-rollers were common on spirea at Ames and specimens brought to the insectary by Prof. J. E. Guthrie were at once placed in breeding cages. August 30, 1916, they were abundant and causing considerable injury to spirea in a nursery near Cedar Rapids, according to Ivan L. Ressler. In July, 1917, the insect was again common at Ames. Prof. B. M. Harrison reported the insects common on spirea at Shenandoah, Charles City, Washington and Cedar Rapids during the summer. The species appears to be common generally over Iowa.

There are evidently two generations in Iowa. Larvæ are recorded as abundant in July and again late in August and during September. They were most common in July. Davis says that two generations occur in Illinois.

From insectary records taken in 1916 and 1917, moths emerged from July 22 to August 9, according to notes taken by H. R. Werner and Ivan L. Ressler. Only one moth was reared in the fall, emerging September 28; 5 to 8 days were spent as pupæ in the summer, with an average of 5.8 days, from 17 records. In September, 8 days were spent as the pupa, but only one record is available.

R. L. Webster.

The Agricultural Index. A cumulative index to agricultural periodicals and bulletins, cumulated quarterly, is a new undertaking in bibliography, indexing some 78 journals. It is a reference work covering a wide range of topics and therefore most serviceable to the general worker though of much value to specialists because of its references along cognate lines. It is probable that experiment station libraries and many of the larger libraries of the country possess copies of the index and it is therefore presumably accessible to most economic entomologists.

[1] Contribution from the Entomological Laboratory, Md. Agr'l Exp. Sta.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1918

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS.

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The opening of another season under war conditions is a challenge to economic entomologists or entomological engineers to justify once more the great practical value of their calling. There will be unexampled opportunities to discriminate between essentials and the comparatively unimportant and it is quite within possibilities to render more service by advising a modified and reduced spraying program designed to control the more serious insect pests, than to advocate a theoretically perfect schedule impractical under present day limitations.

There is more need than ever to watch developments for the purpose of anticipating and effectively controlling insect outbreaks in their incipiency. There should be more expert field entomologists stationed at important crop centers and working in closest coöperation with county agents and various agricultural organizations. The entomologist should demonstrate that one of the most effective methods of increasing crop production is by crop conservation. It is hoped that the organized work of last year conducted under the direction of federal and state authorities may be greatly extended the coming season, though there will probably be greater difficulty in securing enough well qualified men than last year.

Reviews

Field Book of Insects, with special reference to those of northeastern United States, aiming to answer common questions, by Frank E. Lutz. Pages I to IX, 1 to 509, about 800 illustrations, many in color. G. P. Putnam's Sons, New York and London, 1918. 12°. Price, $2.50.

This study in concision and clarity, withal interesting, delightfully so in places, discusses in less than 500 small pages, about 1,400 insects, gives 800 illustrations and touches many of the more interesting biologic, economic and systematic phases of insect life. The book bears the impress throughout of a field naturalist, possessed of a healthy skepticism concerning certain "stock" explanations and he who has felt the call of the wild will find therein much suggestive and inspiring. One notes here and there the reaction of fiction on one phase of science.

The author speaks a good word for the scientific name, though he is not above using common designations. He has dared to be inconsistent with his treatment of various groups, giving keys in some, none in others and though explaining the fundamentals of classification, he has not hesitated to discuss groups or even individual insects from the popular or even historical aspect,—the matter being admirably adapted to the limitations and possibilities of the forms considered. The large number of illustrations go far toward making up for the absence of a glossary to explain the technical terms of the simplified keys. The excellent indexes, habitat and plant and entomological, are extremely serviceable in locating information grouped under the hundreds of names.

There are some errors, presumably some omissions and yet most entomologists will feel that in this little volume they have an exceedingly interesting compilation, while the beginner could hardly find a better introduction to the exceedingly abundant and very important group of animals known to the lay man under the somewhat contemptuous term of "bugs" (*Advt.*).

E. P. F.

Current Notes

Conducted by the Associate Editor

R. K. Vickey is a private in the sanitary corps at camp Meade.

Mr. A. O. Larson, assistant entomologist at the Utah Station, has resigned to accept a position in the high school at Manhattan, Mont.

Dr. W. A. Riley of Cornell University has been appointed professor of parasitology and chief of the Division of Economic Zoölogy at the University of Minnesota.

The Fifth Annual Meeting of the New Jersey Mosquito Extermination Association was held January 31 and February 1 at the Hotel Traymore, Atlantic City, N. J.

P. H. Luginbill, U. S. Bureau of Entomology, Columbia, S. C., has been requested by the medical director of Camp Jackson to give part of his time to camp problems.

According to *Science* Dr. W. D. Hunter of the Bureau of Entomology has been elected a vice-president of the Washington Academy of Sciences, representing the Entomological Society.

Mr. Wallace Park, a graduate of the Kansas State Agricultural College, has been appointed assistant in apiculture in the Iowa Agricultural Experiment Station and entered on his duties February 1.

Mr. W. H. Larrimer, Bureau of Entomology, formerly attached to the West Lafayette, Ind., field laboratory, has been granted an indefinite furlough in order to enter an officers' training camp.

Rev. Harry R. Caldwell has recently presented the American Museum of Natural History with a collection of about 8,000 insects from China, in appreciation of which he has been made a life member.

Mr. A. J. Flebut, Bureau of Entomology, who has been in charge of the work on chestnut weevils, with headquarters at Paxinos, Pa., has been granted an indefinite furlough for the purpose of entering the Officers' Training Camp at Camp Upton, N. Y.

According to *Science*, Mr. Charles A. Hart, systematic entomologist of the Illinois State Natural History Survey, died suddenly of heart disease on February 17. He was an active member of this Association, and a member of the American Society of Zoölogists.

Professor A. G. Ruggles, associate entomologist of the Minnesota University and Station, has been appointed state and station entomologist of Minnesota *vice* F. L. Washburn, who at his own request was granted relief from the position and its attendant police duties.

Dr. Clarence Moores Weed of the State Normal School, Lowell, Mass., formerly professor of Entomology and Zoölogy at the New Hampshire College, Durham, N. H., has been called to Washington, D. C., to take charge of the school gardens of the city during the coming season.

Mr. Frank J. Rimoldi, a recent graduate of Cornell University and a former student of the Connecticut Agricultural College, has been appointed by the Federal Bureau of Entomology as extension entomologist for work on deciduous fruit insects in Massachusetts, Connecticut and Rhode Island.

Entomologists have been commissioned first lieutenants in the army as follows: L. H. Dunn, Army Medical School, Washington, D. C., E. H. Gibson, Camp Humphrey, Va., A. H. Jennings, Camp Shelby, Miss., H. L. Parker, Camp Lee, Va., D. L. Van Dine, Camp Travis, Tex., and Neal F. Howard.

The Brooklyn Entomological Society recently elected officers for 1918 as follows: president, W. T. Bather; vice-president, W. T. Davis; treasurer, Chris. E. Olsen; recording secretary, J. R. de la Torre Bueno; corresponding secretary, R. P. Dow; publication committee, R. P. Dow, editor; C. Schaeffer and J. R. de la Torre Bueno.

Mr. Quincy S. Lowry, assistant entomologist of the Connecticut Agricultural Experiment Station, resigned March 1 to accept a position as extension entomologist with the Federal Bureau of Entomology. Mr. Lowry will work with truck crop insects and will cover Massachusetts, Rhode Island and Connecticut, with headquarters at Amherst, Mass.

Professor Francis Jager, chief of the bee division of the Department of Agriculture of the University of Minnesota, has been granted six months' leave of absence to head a group of men who are to go to Serbia to direct farming operations on a large tract of land. Seed, agricultural machinery and tools will be carried from this country, and preparations are practically completed for transportation facilities.

According to *Science*, Professor William B. Herms, professor of parasitology and acting head of the Department of Entomology, University of California, has been appointed captain in the Sanitary Corps, National Army, and has been ordered to Fort Sam Houston, Texas, for duty. Captain Herms was actively engaged during the past summer and autumn in investigating the sanitation of military camps in the Western Department, particularly as regards mosquitoes and flies.

The lecture course of the California Academy of Sciences included the following lectures by entomologists: January 20, "Forest Insects" (illustrated), by Professor R. W. Doane of Stanford University; January 27, "Experiences in a Georgia Swamp" (illustrated), by Professor J. C. Bradley of Cornell University, but for the college year at the University of California; March 10, "Pine Insects and Their Depredations," by Mr. Ralph Hoppin of the United States Forest Service.

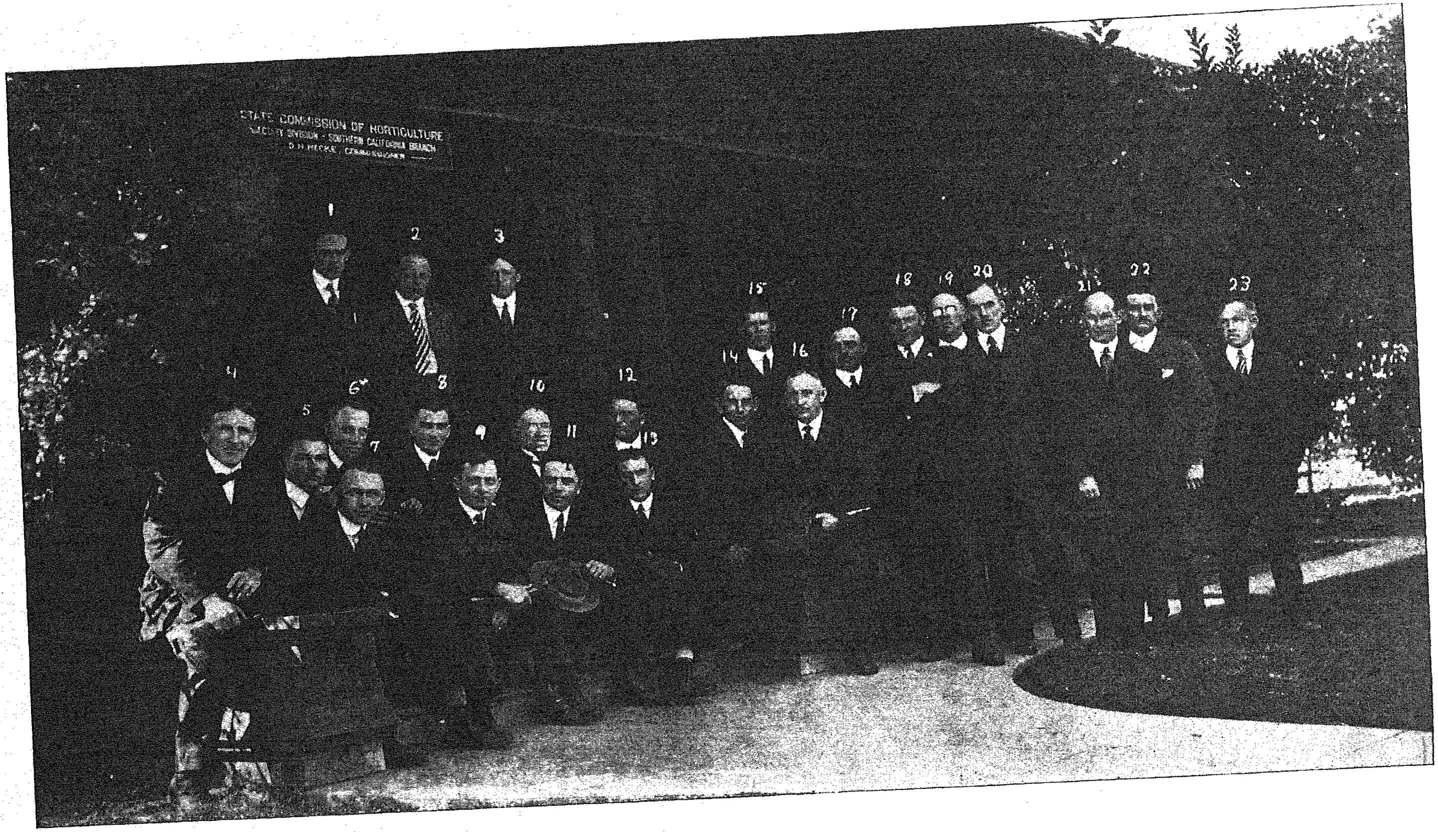
The following resignations from the Bureau of Entomology have been announced recently: C. S. Whittington of the boll-weevil laboratory; H. K. Laramore, special field agent, College Station, Tex., to accept a call to the colors; E. G. Smyth, to accept a state position as extension entomologist in Texas; H. L. Dozier, Tempe, Ariz., to complete his work for a doctor's degree in Florida; E. O. G. Kelly, Wellington, Kan., to enter private business; David Running, apiculture, on account of illness; J. H. Wagner, apiculture; E. P. Barrios, special field agent, extension work in Southern Louisiana; R. C. Pickett, special field agent, extension work in Texas.

The following transfers have been made in the Bureau of Entomology: to the Federal Horticultural Board for temporary work on the pink boll-worm in Texas; U. C. Loftin, H. P. Smith, K. B. McKinney and Tobert Slack; W. M. Davidson,

Sacramento, Calif., temporarily to Alhambra, Calif., for work on coccinellids; Messrs. Edmonston and Hofer, temporarily from Colorado Springs, Col., to Tuscon, Ariz., for work on insects destructive to Mesquite cordwood; F. B. Milliken, Wichita, Kan., to New Orleans, La., mill and grain storage insects; D. E. Fink, Norfolk, Va., to Riverton, N. J., in charge of a new field station for work on truck crop insects; J. D. Smith, southern field crop insects, Valdosta, Ga., to deciduous fruit insects, Washington, D. C.; T. C. Barber, Federal Horticultural Board, to southern field crop insects, Audubon Park, New Orleans, La.; Charles E. Smith, Muscatine, Iowa, temporarily to College Station, Tex.; Marion R. Smith, Plymouth, Ind., temporarily to Baton Rouge, La.; F. R. Cole, Hood River, to Corvallis, Ore.; P. R. Erbaugh, Illinois, to Michigan and Indiana.

The following appointments have been made in the Bureau of Entomology: J. H. Wagner of Colorado, special field agent for apicultural work in Montana, northern Idaho, Washington and Oregon; David Running of Michigan, special field work for apicultural extension work in New York state for the winter season; W. J. Price, formerly of the Virginia Crop Pest Commission, special field agent under the Food Production Act, to take up extension work with deciduous fruit insects in Virginia, with headquarters at Blacksburg; Robert M. Fulton, a graduate of the Washington State College, special field agent under the Food Production Act for work in deciduous fruit insect control in Washington, with headquarters at Pullman; R. C. Pickett of Wisconsin, for work with truck crop insects, College Station, Tex.; C. H. Gable, formerly commissioner of agriculture on the Island of Madeira, specialist on alfalfa insect investigations, Tempe, Ariz.; H. B. Parks, for extension work in cereal and forage crop insects, Texas; A. H. Sherwood, extension work, grasshopper control, South Dakota; H. L. Seamans, extension work in Montana; R. E. Snodgrass, assigned to cereal and forage crop insects; J. R. Horton has been placed in charge of the laboratory at Wellington, Kan.; Rollin La Follette, extension work with citrus fruit insects in California; William T. Ham, special field agent in extension work in Washington and Oregon; R. L. Strand, special field agent in control of cereal and forage crops insects, Montana; F. J. Rimoldi, deciduous fruit insects, and Quincy S. Lowry and George Codding, truck crop insects, extension work in Massachusetts, Rhode Island and Connecticut; W. H. Foster of Colorado, for apicultural work in Montana, Washington and Oregon.

Mailed April 19, 1918.


STATE COMMISSION OF HORTICULTURE
SOUTHERN CALIFORNIA BRANCH
COMMISSIONER

EXPLANATION OF PLATE 8

GROUP PHOTOGRAPH OF MEMBERS ATTENDING THE PACIFIC COAST BRANCH OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS AT RIVERSIDE AND ALHAMBRA, MARCH 28–29, 1918

1, D. B. Mackie
2, G. A. Coleman
3, E. F. Atwater
4, H. P. Severin
5, R. E. Campbell
6, J. D. Neuls
7, A. F. Swain
8, A. S. Hoyt
9, H. J. Quayle
10, H. T. Fernald
11, H. S. Smith
12, E. L. Morris
13, G. P. Weldon
14, G. P. Gray
15, H. J. Ryan
16, R. W. Doane
17, G. S. Demuth
18, C. A. Perrin
19, J. C. Bradley
20, S. B. Freeborn
21, R. S. Woglum
22, E. J. Brannigan
23, H. D. Young

Photograph by C. B. Messenger

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Proceedings of the Pacific Slope Branch of the American Association of Economic Entomologists

The third annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held at the Citrus Experiment Station, Riverside, California, on March 28th, and on the following day at the Branch Laboratory of the State Insectary at Alhambra. In the afternoon of March 28th, a field excursion was made to the Yucaipa apple section about twenty-five miles from Riverside, and on the afternoon of the 29th an inspection was enjoyed of the famous Huntington gardens at Pasadena through the courtesy of the Superintendent, Mr. Hertrick. The government entomological laboratories at Alhambra, representing the divisions of citrus and subtropical fruits, and truck crops, were also visited.

PART I. BUSINESS PROCEEDINGS

The first meeting, which was held in the lecture room of the Citrus Experiment Station, was called to order by President G. P. Weldon at 10 a. m. Thursday, March 28th. The following members and visitors were present:

E. F. Atwater, U. S. Dept. Agr., Washington, D. C.
F. A. Bahmeier, Farm Adviser, San Bernardino, Cal.
J. T. Barrett, Citrus Experiment Station, Riverside, Cal.
J. C. Bradley, Cornell University, Ithaca, N. Y.

E. J. Brannigan, State Insectary, Alhambra, Cal.
O. B. Burger, Citrus Experiment Station, Riverside, Cal.
R. E. Campbell, U. S. Dept. Agr., Alhambra, Cal.
G. A. Coleman, University of California, Berkeley, Cal.
G. S. Demuth, U. S. Dept. Agr., Washington, D. C.
R. W. Doane, Stanford University, Cal.
H. T. Fernald, Massachusetts Agricultural College, Amherst, Mass.
S. B. Freeborn, University of California, Berkeley, Cal.
G. P. Gray, University of California, Berkeley, Cal.
A. S. Hoyt, Quarantine Office, Los Angeles, Cal.
D. B. Mackie, State Commission of Horticulture, Sacramento, Cal.
C. B. Messenger, California Cultivator, Los Angeles, Cal.
E. L. Morris, County Horticultural Commissioner, Santa Ana, Cal.
J. D. Neuls, Braun Corporation, Los Angeles, Cal.
C. A. Parrin, State Insectary, Alhambra, Cal.
H. J. Quayle, Citrus Experiment Station, Riverside, Cal.
H. J. Ryan, U. S. Dept. Agr., Alhambra, Cal.
H. P. Severin, University of California, Berkeley, Cal.
D. D. Sharp, County Horticultural Commissioner, Riverside, Cal.
H. S. Smith, State Insectary, Sacramento, Cal.
A. F. Swain, Citrus Experiment Station, Riverside, Cal.
R. S. Vaile, Citrus Experiment Station, Riverside, Cal.
G. P. Weldon, State Commission of Horticulture, Sacramento, Cal.
R. S. Woglum, U. S. Dept. Agr., Alhambra, Cal.
H. D. Young, U. S. Dept. Agr., Alhambra, Cal.

President G. P. Weldon: The meeting will please come to order. In the absence of the Secretary, E. O. Essig, it will be necessary to have some one act in that capacity.

H. J. Quayle was nominated to act as Secretary for the meetings. The report of the Secretary and Treasurer was not presented.

The following applications for associate membership were recommended to the regular membership committee of the Association for final action:

Bridwell, J. C., Honolulu, H. T.
Clausen, C. P., State Insectary, Alhambra, Cal.
Kimsey, M. E., Scottsvale, Ariz.
Mackie, D. B., State Insectary, Sacramento, Cal.
Penny, D. D., State Insectary, Sacramento, Cal.
Vosler, E. J., State Insectary, Sacramento, Cal.
Ryan, H. J., Alhambra, Cal.

The second part of the business meeting was held at Alhambra, on Friday, March 29th, at which meeting President G. P. Weldon also presided.

President G. P. Weldon: At our last meeting a committee on entomological research was appointed and I will now call upon Professor Doane, the chairman of that committee for the report.

REPORT OF THE COMMITTEE ON ENTOMOLOGICAL RESEARCH

By R. W. Doane, *Chairman*

This committee was appointed to coöperate with the Pacific Coast Research Conference of the State Council of Defense. The committee outlined a series of problems which it thought it would be advisable to undertake, but the Executive Committee, owing to lack of funds, were not able to authorize this work.

In spite of this, two of the projects proposed were undertaken. The first was a continuation of the study of the mosquito situation in California, the State Board of Health coöperating in this and furnishing funds. The second was an investigation of the insects affecting stored foods in warehouses and mills. This work was done with the coöperation of the Federal Food Commission of California, which furnished funds for the purpose.

President G. P. Weldon: We will now proceed to the election of officers.

A motion was made and carried that the nominating committee be dispensed with and that nominations for officers for the ensuing year be made from the floor. The following officers were elected:

President—H. J. Quayle.
Secretary-Treasurer—E. O. Essig.

The following were appointed to the committee on membership: R. S. Woglum, H. S. Smith and R. W. Doane.

The meeting adjourned with the tentative understanding that the next annual meeting would be held in connection with the Pacific Coast Branch of the American Association for the Advancement of Science.

H. J. Quayle,
Acting Secretary.

PART II. PAPERS AND DISCUSSIONS

In the absence of a formal paper, President G. P. Weldon made a few appropriate remarks, calling particular attention to the practical things that entomologists may do at this time in the conservation of foods and food products.

President G. P. Weldon: I will now call for the reading of papers and the first one is by O. F. Burger and A. F. Swain, entitled "A Fungus Enemy of the Walnut Aphis."

OBSERVATIONS ON A FUNGUS ENEMY OF THE WALNUT APHIS IN SOUTHERN CALIFORNIA[1]

By O. F. Burger, *Instructor in Plant Pathology*
and
A. F. Swain, *Assistant in Entomology*

Introduction

In the spring and early summer of 1917 the walnut aphis (*Chromaphis juglandicola* Kalt.) was very abundant in the various walnut growing sections of Southern California. In many places the infestations were so severe that control measures were inaugurated. This was especially true in the vicinities of Santa Barbara, Santa Paula, El Monte and Tustin. Several growers dusted their trees with combinations of dry sulfur and tobacco dust, in an attempt to control both the aphids and the walnut blight. Under the direction of the Department of Entomology of the Citrus Experiment Station, portions of the walnut groves of the San Joaquin Fruit Company, near Irvine, Orange County, were sprayed in the latter part of May, with nicotine sulfate and lime sulfur, and with nicotine sulfate and soap, with excellent results in controlling the aphids. A grove near Santa Paula was sprayed about the same time with nicotine sulfate and soap under the direction of the Ventura County Horticultural Commissioner, with equally good results.

As stated above the infestation of walnut aphis was exceedingly heavy, and gave promise of causing considerable loss. Even in Riverside County where ordinarily this aphis is of no importance whatever, a severe infestation occurred during the latter part of May and in June. One hundred leaves from a tree in Riverside on June 8, showed an average of about 70 aphids per leaf, which is an extremely large infestation for that vicinity. On June 6, in a grove in Santa Ana, an average of 106 aphids per leaf was counted, while the grower informed the writers that two weeks earlier there had been many more present. In the Thorpe grove near Santa Paula on June 11, there was found to be an average of 62.5 aphids per leaf, and on the Limoneira Rancho a few days later, about 22 per leaf were noted. The great abundance of aphids was also observed in Santa Barbara County at Carpenteria, Naples and Santa Barbara; in Los Angeles County at El Monte, Spadra and Walnut; and in Orange County at Anaheim, Orange and Tustin.

[1] Paper No. 49, University of California, Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, California.

FIELD INVESTIGATIONS

Several groves in the vicinity of El Monte were heavily infested and many of them were treated. The observations were confined to the groves of the Cogswell Ranch which were dusted with various combinations of sulfur and tobacco dust during the latter part of May. A few days later the owner noticed that the infestation was considerably lighter. On June 4, the writers examined these groves and found that the aphids to a large extent had disappeared. Bodies of many dead aphids were observed still clinging to the leaves, and these were thought at first to have been killed by the dust, but they were also observed on untreated trees. It was further noticed that live aphids were no more numerous on the untreated than on treated trees. A microscopical examination of the bodies of the dead aphids brought out the fact that they were infected with a fungus which later proved to be a new species of *Entomophthora*.

The discovery of aphids infected with this fungus resulted in a more thorough examination of the conditions on June 9. Table 1 gives the results of counts made on the various groves.

TABLE 1—WALNUT APHIS IN COGSWELL GROVES, EL MONTE, JULY 9, 1917

	Number of leaves	Number of aphids per leaf	Percentage of aphids infected	Number of living aphids per leaf
A Treated	30	40.07±2.87	87.02±1.51	5.93±0.65
B Treated	50	17.56±0.94	73.12±2.27	4.72±0.64
C Treated	50	28.94±1.50	71.73±1.73	8.18±0.69
D Untreated	49	42.18±2.80	88.56±1.17	5.16±0.39
E Untreated	40	38.60±2.67	83.81±1.33	6.17±0.94

An examination of this table shows that the average number of aphids per leaf ranged from 17 to 42 in the various groves, but on account of this fungus the average of living aphids was only 5 to 8 per leaf, the percentage of infection being about the same in all groves, both treated and untreated. It must be borne in mind that the number of aphids per leaf does not represent a true record of the previous infestation, for many of the dead aphids had either fallen to the ground or been blown off the leaves. However, this table does show that the fungus was a very important factor in the elimination of the aphids.

Observations were made in Ventura County about this time, where it was found that aphids were present in great numbers but that the fungus was also present. On May 11 one grove near Santa Paula was found to be heavily infested. It was also observed that a small percentage of infected aphids were present. On June 11 not a single

living aphid could be found in this grove, although the mummified bodies of dead aphids were abundant. Unfortunately no counts were made at either examination. It is not claimed by the writers that the fungus was the sole agent in the eradication of the aphids on this grove, for large numbers of ladybird beetles and larvæ, and of syrphid fly larvæ were observed at the time of the first examination. However, the fact that such a large number of infected bodies was present, when living aphids were absent, proves that the fungus was an important agency in controlling the aphis.

Natural Factors in the Control of the Walnut Aphis

During the week June 11 to June 18, extremely high temperature and correspondingly low humidity prevailed throughout Southern California. In fact, that week was the hottest period for the time of year ever reported in Southern California. Table 2 gives the maximum temperatures recorded at various points for the week.

Table 2—Maximum Temperatures (F.°), Week Ending June 19, 1917[1]

June	12	13	14	15	17	18
Los Angeles	79	80	100	99	105	85
Santa Ana	79	87	104	95	97	83
Pomona	93	99	110	112	117	100
Riverside	98	105	112	114	117	103
Santa Barbara	76	80	92	105	115	77

This extreme heat resulted in the death of a large percentage of aphids throughout the walnut growing sections of Southern California, and was by far the most efficient check of the season. In only one case were any living aphids observed by the writers during the following week. This was on the Limoneira Rancho, Santa Paula, where on June 19 there was an occasional aphid found. Such aphids were found only on leaves well in the interior of large trees, where they were protected considerably from the heat.

Among the natural agents which contribute to the control of this aphid, the heat of summer can be mentioned as very important in certain sections. To this heat is largely due the credit for the practical absence of the walnut aphis in such interior sections as Riverside, Elsinore and Hemet. In harmony with this is the fact that in cool, humid weather the aphids seem to thrive best. The early part of the season of 1917 was cool and humid, and this condition lasted until June.

[1] These records were obtained from the Daily Weather Map, United States Department of Agriculture, Weather Bureau, Los Angeles, California, June 13–19, 1917, with the exception of those for Santa Ana which were obtained from the records of a thermograph placed in the Rohrer Grove, by the Department of Plant Pathology of the Citrus Experiment Station.

Insect Enemies

Insect enemies of the walnut aphis, particularly the predaceous enemies, are a very important factor in their control. Observations by the writers showed that these were present everywhere, in some cases being very abundant and apparently accomplishing a great reduction in the aphid infestations. Among the more common enemies may be mentioned the ashy gray ladybird beetle (*Olla abdominalis* Say). About the middle of May the eggs of this species were abundant in the vicinity of Santa Paula, El Monte, Walnut and Tustin. By the latter part of the month, the larvæ were present and feeding extensively on the aphids. These pupated in early June and the adults appeared shortly before the extreme heat. On the San Joaquin Fruit Company's groves, these were very abundant.

Another common predaceous enemy was *Hippodamia convergens* Guerin, the larvæ and adults of which were present from May to September in all groves examined by the writers. The third in abundance was the green lace wing (*Chrysopa californica* Coquillet), which was very plentiful in May and June in Ventura, Los Angeles and Orange Counties. From time to time larvæ of various syrphid flies, particularly *Catabomba pyrastri* (Linnæus), were noted, although never in any great numbers. Occasionally larvæ of *Sympherobius angustus* (Banks) were found, and in the vicinity of Walnut and Spadra, Los Angeles County, adults and larvæ of *Scymnus* sp. were observed. The inclination is to give predaceous enemies credit for any reduction of aphids not proven to be directly attributed to other agencies, as for instance the heat and fungus parasites.

Reinfestation of Groves

About six weeks after the hot weather mentioned above, an examination of the walnut groves of the San Joaquin Fruit Company was made. The aphids were still very scarce. A count of 186 leaves gave an average of 6.54 ± 0.30 aphids per leaf, showing that as yet they had not been able to reëstablish themselves to any great extent. By September 12, three months after the excessive heat, a count was again made, 50 leaves showing an average of but 12.02 ± 1.39 aphids per leaf. In that vicinity, however, the summer had been dry and warm, which together with the predaceous enemies had kept the infestation down. Table 3 gives the results of a count made on the Cogswell groves, El Monte, on September 12.

TABLE 3—WALNUT APHIS IN COGSWELL GROVES, EL MONTE, SEPTEMBER 12, 1917

	Number of leaves	Number of aphids per leaf	Percentage of aphids infected	Number of living aphids per leaf
B	30	84.57± 5.14	1.42±0.27	83.33± 5.14
D	10	63.10±12.71	1.43±0.96	62.20±12.81
F	20	51.30± 6.11	3.51±1.46	49.50± 6.17

An examination of this table shows that practically three months after the hot period, the aphids had been able to reinfest these groves quite extensively. At that time, however, the fungus, although present, was a negligible factor in control, since less than 2 per cent of the aphids were infected. The practical absence of the fungus was due undoubtedly to the summer heat and drought. However, at that season of the year, aphid infestations are of no commercial importance.

OBSERVATIONS AT SANTA ANA

In Santa Ana, Orange County, the Department of Plant Pathology of the Citrus Experiment Station had two walnut trees enclosed in a frame covered with cheesecloth for the purpose of studying walnut blight. Temperature and evaporation records were kept throughout the summer both within one of these frames and outside in the grove. It may be noted that the temperatures from August 1 to September 20 (the period of observations on the aphids) were practically the same outside as inside the frame, being but one or two degrees lower on the average inside. However, the humidity as obtained by the amount of evaporation recorded by the Livingston atmometers was higher within the tent than without. In fact, there was marked difference (see chart I).

It was noted (see Table 2) that in this locality the maximum summer temperature was 104 degrees F, which was considerably lower than in most of the sections of Southern California where any observations were made. Also the humidity there is comparatively high. As a result the infestation was not so depleted in June as in other localities. On July 26 under tent 1, a count of the aphids on 35 leaves showed an average of 44.51±4.09 aphids per leaf, with a mortality of 94.43±0.25 per cent caused by the fungus. On August 1 no live aphids could be found on this tree.

About every two weeks, from August 1 until September 20, counts were made of the number of aphids on leaves from the tree under tent 2, and on trees in the surrounding grove. The results of the counts are included in Tables 4 and 5.

CHART I
RELATIVE EVAPORATION

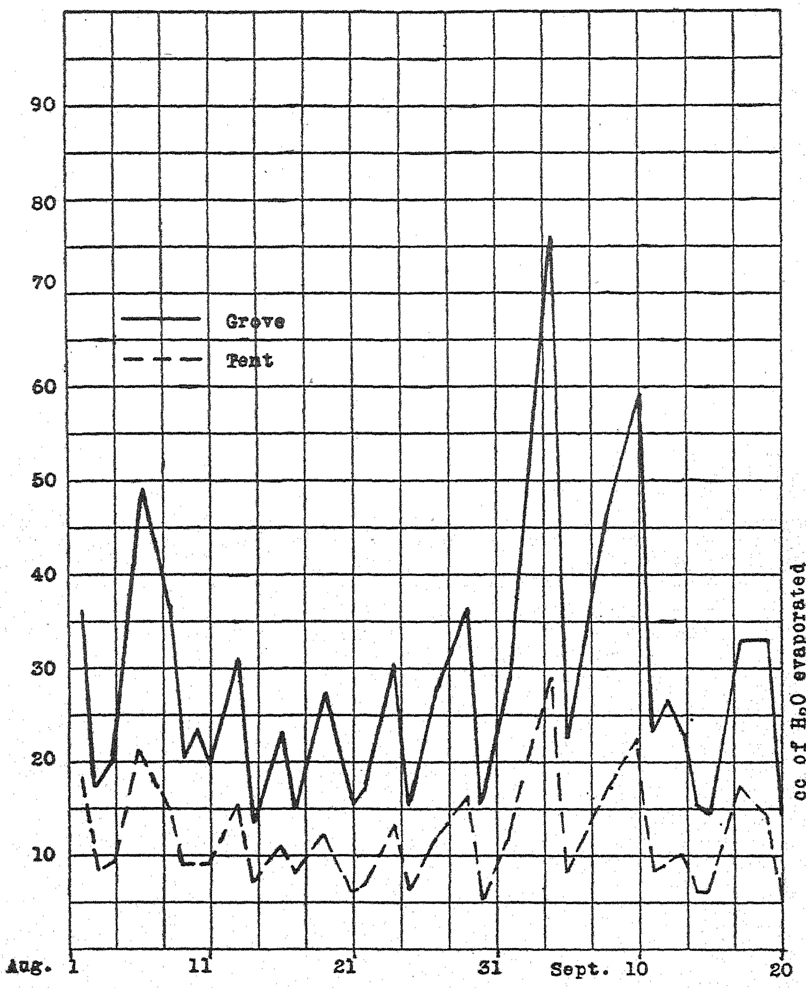


TABLE 4—WALNUT APHIS IN GROVE IN SANTA ANA, ORANGE COUNTY

Date	Number of leaves examined	Number of aphids per leaf	Percentage of aphids infected	Number of living aphids per leaf
August 1........	60	41.35± 3.17	0.48±0.29	41.10± 3.17
August 16.......	10	131.70±16.86	4.56±1.07	125.90±16.86
August 30.......	20	35.25± 3.74	37.45±2.24	34.55± 2.68
September 12....	20	13.60± 2.21	93.38±1.60	0.90± 0.20
September 20....	10	8.80± 0.81	94.45±1.24	0.20± 0

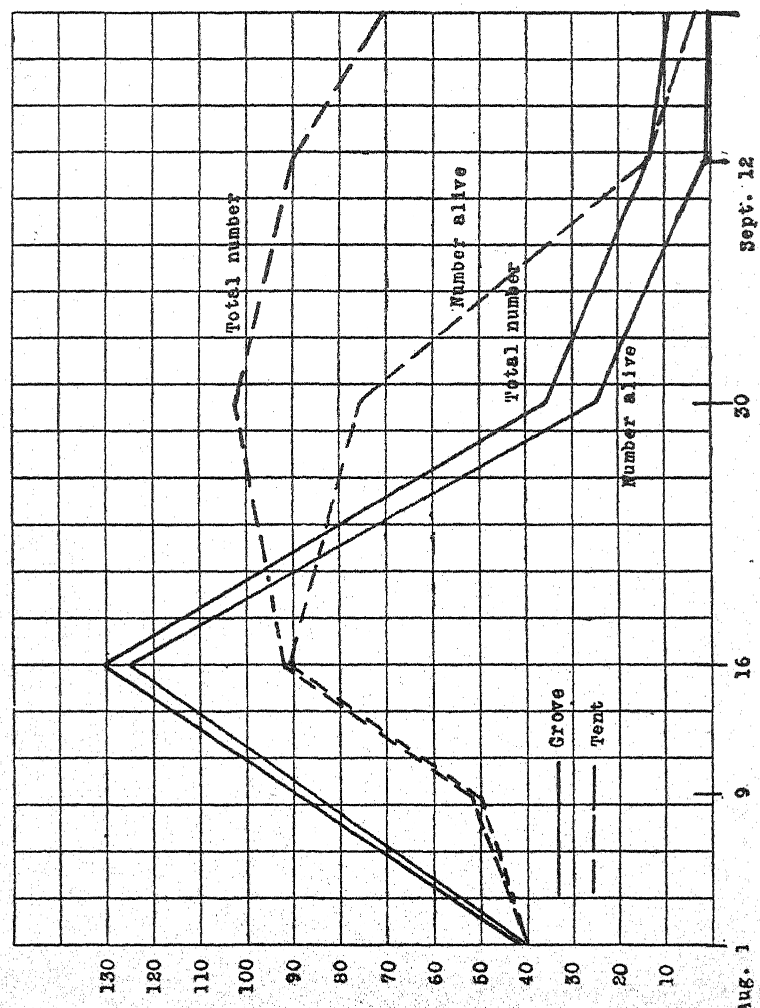
TABLE 5—WALNUT APHIS IN TENT 2, SANTA ANA, ORANGE COUNTY

Date	Number of leaves examined	Number of aphids per leaf	Percentage of aphids infected	Number of living aphids per leaf
August 1........	20	40.00±11.28	0.	40.00±11.28
August 9........	13	50.23± 9.55	0.15± 0.36	50.15± 9.56
August 16.......	10	91.80±10.50	1.20± 0.30	90.70±10.33
August 30.......	10	102.30± 4.45	25.71± 2.95	76.00± 4.50
September 12....	10	89.80± 9.95	84.97± 1.99	13.50± 2.19
September 20....	10	70.50± 7.91	95.60± 1.16	3.10± 0.98

On August 1 it was found that the grove there was an average of slightly over 41 aphids per leaf, of which about one half of 1 per cent

CHART II

AVERAGE NUMBER OF APHIDS PER LEAF



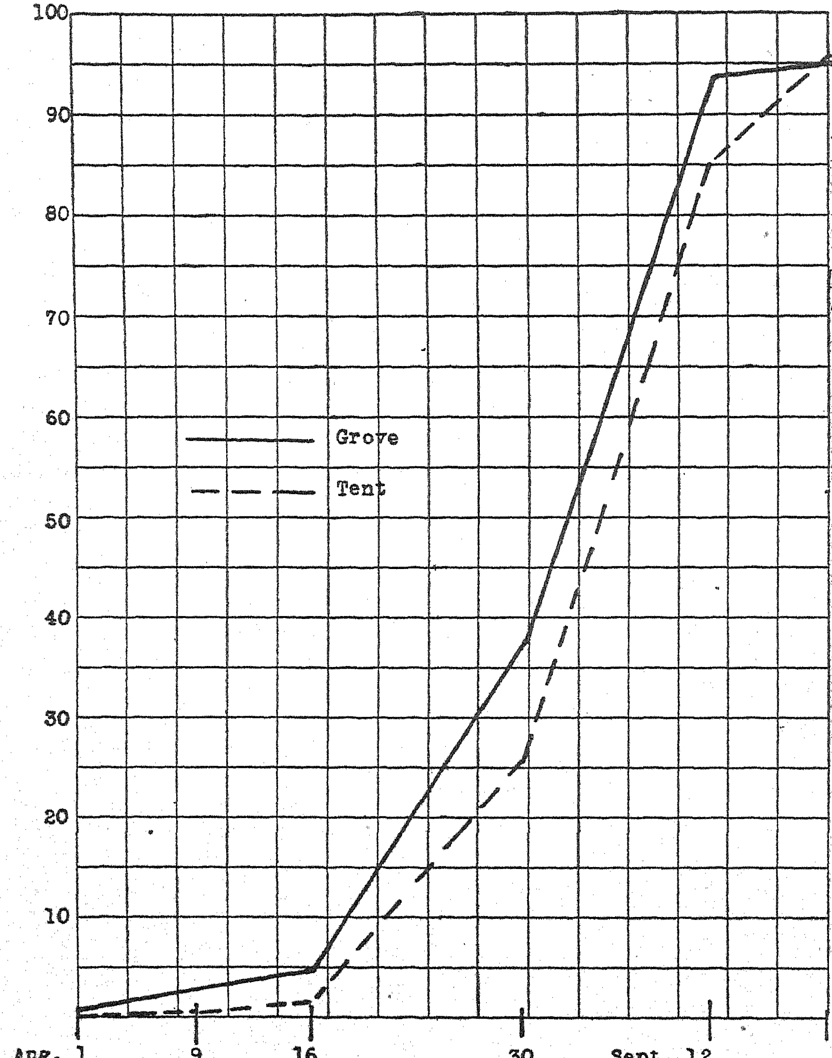
were infected with the fungus. In the following two weeks these increased greatly, until on August 16 there were present about 132 aphids per leaf. The percentage of infection had also increased, but not so rapidly, there being about 4½ per cent of the aphids killed by the fungus. In the next two weeks the number of aphids per leaf had dropped to but slightly over 35, of which some 37 per cent were infected. Two weeks later, on September 12, only about 13 aphids per leaf remained, and over 93 per cent of these were infected with the fungus, leaving an average of a little less than one aphid per leaf alive. By September 20 the number had increased to almost 9 per leaf, but again the percentage of infection was high, being almost 95 per cent, with the result that the aphids were practically eradicated.

This almost complete eradication is accounted for by the action of the fungus together with other natural agencies. Which of these was the most important the writers cannot state, but the presence of the mummified bodies of aphids infected by the fungus permits the interpretation that this parasite was largely responsible for this great mortality.

More convincing results are obtained from a study of Table 5. This is a record of counts made on the tree under tent 2, from August 1 to September 20. During observations covering a period of four months (June to September) no insect enemies of the walnut aphis were ever found in this tent. No specimens of *Coccinellidæ*, *Syrphidæ* or *Chrysopidæ* were seen, yet results parallel to those observed in the grove were found. On August 1 an average of 40 aphids per leaf was present and none were infected by the fungus. This tree had been sprayed in the spring before the buds opened with lime sulfur, with the result that no aphids appeared until very late. In fact it was at this time that the first real infestation was noticed. These probably were the succeeding generations of some few that gained entrance accidentally from time to time during the summer. By August 9 they had increased, as might be expected, to about 50 per leaf, with a small percentage infected with the fungus. A week later the number per leaf was found to be about 92, with about one dead as a result of fungus attack. Approximately 102 aphids per leaf were present on August 30, but by this time the percentage of infection had increased to 25.71 per cent, with the result that only 76 per leaf remained alive. These increased to about 90 aphids per leaf in the next two weeks, the number infected increasing as well, although in greater proportion. Almost 85 per cent were so infected, leaving but 13.5 per leaf alive. On September 20, when the last observation was made, there were found to be 70.5 aphids per leaf on an average, of which 95.6 per cent were infected by the fungus, leaving only slightly more than 3 aphids per leaf alive.

CHART III

PERCENTAGE OF INFECTION



Here the infestation had been almost eradicated without the aid of any predaceous insect enemies. Charts II and III show the amount of infestation and percentage of infection in the grove and in tent 2.

Other Hosts

Clinging to the under side of the walnut leaves was often found a small bark louse belonging to the genus *Psocus*. These bark lice

were examined from time to time as they were found, and without any exception they were infected with this same *Entomophthora.*

Description of the Fungus

During the spring of the year and in places where the humidity is rather high due to the fogs, an *Entomophthora* is parasitic upon the walnut aphis, *Chromaphis juglandicola* (Kalt.). The disappearance of this insect during the summer months was always thought to be due to heat and predaceous insects. Only one record has been found where a fungus was responsible for the control of this pest.[1] The writers have been unable to learn whether or not this was the same fungus as that herein described.

This fungus attacks the aphid in all its stages of growth from the mature winged form to the small first instar larva. One of the first signs of parasitism of the insect is the sluggish movement of the individual attacked. Later the body turns a darker yellow and is somewhat swollen. Then from the body of the dead aphid the small hyphæ begin to protrude, which in due time form a white fringe about the body (pl. 9, fig. 1). In some cases the protruding hyphæ are in such numbers that the insect looks like a white, glistening, spherical mass, which later turns a light brown in color. When the bodies of the insects are crushed and placed under the microscope, they are seen to be filled with large septate anastomosing hyphæ. These mummified bodies remain for some time, hanging to the leaves by means of haustoria until removed by some external agency.

The spores of the fungus are bell-shaped with a sharply pointed apex (pl. 9, fig. 2). These spores are borne on a club-shaped conidiophore. When the spore is mature, it is shot from the conidiophore with considerable force. Clinging to the spore is a mass of protoplasm that glues it to any object which it happens to strike. If the object happens to be the body of an insect, the spore germinates and the germ tube penetrates the insect. If, however, the spore happens to strike an unfavorable object for its growth, it again forms a secondary spore (pl. 9, fig. 3), which is much smaller but is ejected in the same manner, and the process is repeated until the spore either is exhausted or finds a suitable host. On the wings and legs of the affected insects could be seen many of the discharged spores imbedded in a cushion of protoplasm. Many of these spores had germinated and produced the secondary spores.

Some of the dead aphids were black and were thought to be attacked

[1] Davidson, W. M. Walnut aphids in California. U. S. Dept. Agr., Bull. 100, page 35, 1914.

by a *Cladosporium*, but when examined under the microscope they were found to be filled with dark brown spherical bodies about 30 microns in diameter. These spherical bodies are believed to be the resting spores of the fungus. An attempt was made to germinate the resting spores but with no success.

Entomophthora chromaphidis n. sp.

Conidia bell-shaped with broad truncate base and sharply pointed apex; 11–14 microns by 10–11 microns; usually containing a single large oil globule, and surrounded after discharge by a mass of protoplasm. Conidiophores simple or compound; broad at the apex and gradually tapering to a narrow base; producing white or brownish masses which may or may not coalesce over the body of the host. Secondary conidia oval with rounded apex and formed by direct budding from the primary spore.

Resting spores, azygospores, brown, 30 microns in diameter. Host attacked by rhizoids.

Host: *Chromaphis juglandicola* (Kalt.), *Psocus* sp.

Habitat: California.

Explanations to Plate 9

Fig. 1. The fungus growing from the body of an aphid making a white fringe.
Fig. 2. A discharge spore embedded in the ejected mass of protoplasm.
Fig. 3. A discharge spore producing the secondary spore.

Summary

1. In the spring of 1917 the walnut groves of Southern California were heavily infested by *Chromaphis juglandicola* (Kalt.).

2. Although a period of extreme heat in June, and the presence of numerous insect enemies throughout the season were responsible for the death of a large percentage of these aphids, it was noted that a fungus also contributed to their mortality.

3. Before the period of extreme heat, in El Monte, as high as 88 per cent were killed by this fungus (*Entomophthora chromaphidis* n. sp.).

4. Some time after this period of extreme heat, the aphids increased rapidly but under the conditions noted were effectively controlled by this fungus.

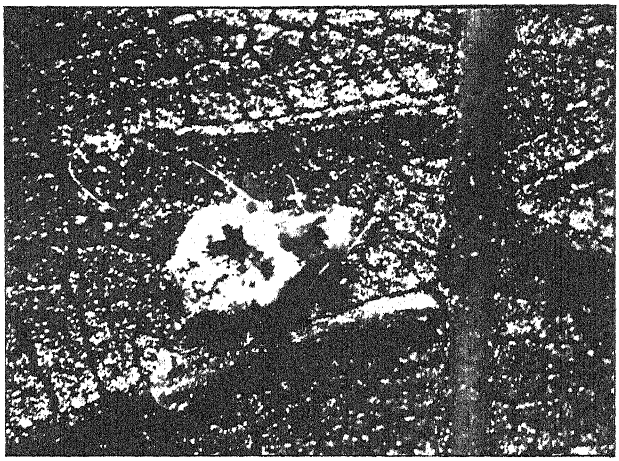
President G. P. Weldon: This paper is now before you for discussion.

H. S. Smith: Have you tried to infect the aphids artificially with this fungus?

O. F. Burger: No opportunity was presented during the past year.

H. S. Smith: Do fungus enemies control the white-fly in Florida?

O. F. Burger: In certain instances, as at Datonia where more or less close observations were made, fungus enemies did seem to control



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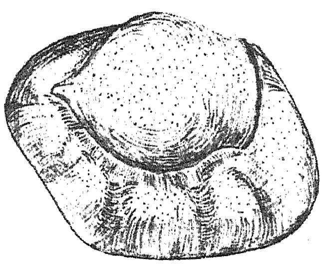

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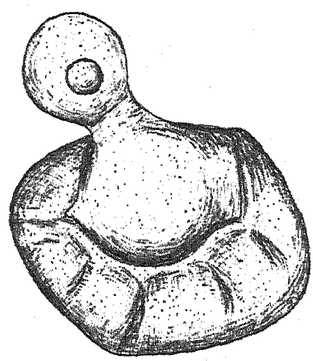

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the white-fly, but they do not effect commercial control in the high pine lands. At Datonia the fungus was sprayed on to the trees, so that it was a case of the artificial use of the fungus.

R. S. Woglum: I understand that the lime sulphur which is used in Florida prevented the development of the fungus. In your paper the lime sulphur did not appear to have any effect on the fungus in this State.

O. F. Burger: As I recall the experiments, lime sulphur did check the fungus, as well as the insects, but where the trees were sprayed with Bordeaux, the fungus was unable to thrive, but the insects multiplied rapidly.

G. P. Gray: The difference in the effect of sulphur may be different according to the fungus in question, as for instance, the downy mildew and the powdery mildew.

R. S. Woglum: How does the Entomophthora fungus enter the insect?

O. F. Burger: The spores of the fungus are discharged from the conidiophore with considerable force. Adhering to each spore is considerable protoplasm, so whatever object the spore strikes it becomes glued to it. If the spores happen to hit an insect it becomes glued to the body. The spore then germinates and the hyphæ enter the insect.

President G. P. Weldon: The next paper is by William M. Davidson, on "Alternation of Hosts in Economic Aphids," which will be read by A. F. Swain.

ALTERNATION OF HOSTS IN ECONOMIC APHIDS

By W. M. Davidson, *U. S. Bureau of Entomology*

In recent years considerable strides in forwarding our knowledge of the peculiar habit of many of the *Aphididæ* to the alternation of host plants have been made.

This work has centered mainly about plant-lice of economic interest.

True alternation of hosts implies a summer host or hosts and a winter host or hosts, the latter harboring the egg or dormant stage and a series of actively feeding spring generations and the former supporting only actively feeding generations through the summer and fall. Almost invariably the summer and winter hosts are widely separated in a botanical sense. Frequently there is more than one summer host and these are not necessarily close botanical relations. On the other hand the winter hosts are generally few and always, when more than one, closely related. Thus we find the Hop Aphis (*Phorodon humuli*

Schrank) alternating between hop and plum, two plants widely separated botanically, or the Black Cherry Aphis (*Myzus cerasi* Fabr.) migrating back and forward between cherry and *Lepidium*, a small cruciferous plant. Again the summer forms of the Spinach Aphis (*Myzus persicæ* Sulz.) are equally at home on lettuce, a composite, on turnip, a crucifer, or on parsley, an umbellifer. Similarly the Bean Aphis (*Aphis rumicis* L.) feeds in summer upon leguminous and Chenopodiaceous plants alike.

In many of the species complications exist by reason of the fact that the insects may live the year around on the summer host or hosts. The root-inhabiting species all have this habit: the Beet Aphis (*Pemphigus betæ* Doane) normally winters on *Populus* but colonies may occur on beet or other roots any time of the year, and similarly the woolly aphids of apple and pear (*Eriosoma lanigerum* Haus. and *E. pyricola* B. & D.) pass the winter in a dormant state on elms and in an active state on apple and pear, the normal summer hosts respectively. It might here be observed that in California, at least in localities where both the apple and pear woolly aphids abound, the spring forms of the pear insect are very commonly marked on elms whereas these forms of the apple species are quite rare on the winter host.

In the southern and southwestern portions of the United States the semi-tropic climate is mild enough to allow aphids to feed and reproduce through the winter months. Thus several species which in the temperate conditions in the north hibernate only in the egg stage on their winter hosts, in the south pass the whole year on the summer hosts without suspending reproductive activity. Such a form is the Spinach Aphis (*Myzus persicæ*). In the north the winter is passed in the egg stage on stone fruits and the resultant spring generations at times do much damage to these trees, but in the south the aphids feed on vegetable crops and weeds without performing their cycle on the fruit trees, this habit thereby eliminating injury to these tree hosts. Another such species is the Oat Aphis (*Aphis prunifoliæ* Fitch) which winters in the north on apple but in the south reproduces the year around on grasses and grains, and therefore in the semi-tropic zone apples escape injury from *prunifoliæ*. It should be stated, however, that due to their viviparous reproduction throughout winter both these species are liable to occur in spring on the summer hosts in greater abundance in the south than in the north, and thus the absence of injury to the fruit trees is counterbalanced by increased infestation on vegetable and grain crops.

In considering the different aphid species of economic importance, it is found that in a few cases both the winter and summer hosts are economic plants. In this group we find *Myzus persicæ*, an aphid

with a long list of hosts comprising most of our cultivated plants, and *Aphis prunifoliæ*, principally a pest of grains and corn. These two have been mentioned previously. Also there is the Clover-apple Aphis (*Aphis bakeri* Cowan) wintering on apple and summering on clovers, and *Phorodon humuli* alternating between plum and hop, chiefly injurious to the latter.

In a group containing those species whose summer hosts alone are of economic importance there occur several species; the Potato Aphis (*Macrosiphum solanifolii* Ashmead) is a pest of tomato, potato, egg-plant, cotton and lettuce; the Grain Aphis (*Macrosiphum granarium* Kirby) infests grains and grasses; both these aphids migrate to roses in the fall in temperate climates, but in the sub-tropical zone they may occur the year around on their summer hosts. In California they appear to feed and reproduce in the winter season both on rose and on the summer hosts. *Aphis cerasifoliæ* Fitch is a species which passes the winter season on choke-cherry and the warm part of the year on grains and grasses, and may be synonymous with *A. padi* Linn. *Aphis rumicis* which attacks many varieties of beans is said to winter on *Euonymus* in temperate climates. The parsley Aphis (*Rhopalosiphum capreæ* Kaltenbach) sometimes a pest on umbelliferous crops winters on willows: the Eastern Grape Aphis (*Macrosiphum illinoisense* Shimer) has been found to migrate in the fall to *Viburnum opulus*, whereon the eggs are deposited, to be followed in spring by a return migration to grape. In this group belong also the woolly aphids of beet, apple and pear, previously mentioned.

A third group contains those species whose winter hosts alone are economic plants. There are two wintering on saxifragaceous and six on rosaceous plants. The former are *Rhopalosiphum lactucæ* Kaltenbach, which migrates back and forward between Currant, Gooseberry and Sow-thistle (*Sonchus*), and *Myzus ribis* Linn. wintering on currants and migrating to and from *Stachys* and *Leonurus* of the Menthaceæ. The others are well-known pests of fruit trees; the Rosy Apple Aphis (*Aphis malifoliæ* Fitch) migrates between apples and rib-grass and plantains; the Black Cherry Aphis (*Myzus cerasi*) between Cherry and *Lepidium;* the remaining four winter on stone fruits, the Rusty Plum Aphis (*Aphis setariæ* Thomas) passes the summer on grasses, the Mealy Plum Aphis (*Hyalopterus arundinis* Fabr.) on reeds, the Reddish-Brown Plum Aphis (*Rhopalosiphum nympheæ* Linn.) on a number of water plants, chiefly liliaceous, and the Green Plum Aphis (*Aphis cardui* Linn.) on thistles.

Of the twenty-one species noted above at least fourteen, possibly fifteen or sixteen, are common to Europe and America.

Strictly European economic species with alternate host habits have not been discussed in this paper.

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PRESIDENT G. P. WELDON: Is there any discussion of this paper?

G. P. GRAY: The weeds which were mentioned in this paper as hosts of the aphids, brings up the question of the relation of weed control to insect control.

G. P. WELDON: Is Amaranthus a summer host plant of the rosy apple aphis? Bremner has reported in the Monthly Bulletin of the

California State Commission of Horticulture that he found an infestation on Amaranthus.

A. F. SWAIN: I think it was only an accidental infestation.

PRESIDENT G. P. WELDON: The next paper on the program is by H. J. Quayle, entitled "Cyanide Fumigation: Diffusion of Gas Under Tent and Shape of Tree in Relation to Dosage."

CYANIDE FUMIGATION[1]

DIFFUSION OF GAS UNDER TENT AND SHAPE OF TREE IN RELATION TO DOSAGE

By H. J. QUAYLE

The practical query "is there a better killing of scale insects secured at the top than at the bottom of the tree," in citrus fumigation, suggested the following experiments. More or less serious injury sometimes occurs in the top of high trees. If the dosage is reduced to avoid this injury, the question then arises as to the effectiveness of the reduced dosage in all parts of the tree.

Citrus trees vary considerably in shape from the low broad lemon tree to the tall narrow seedling orange tree. In one case the extreme may be a tree whose circumference is twice the distance over the top, while in the other the circumference and the distance over the top may be equal.

It may be possible to determine the concentration of the gas in different parts of the tent by chemical means, but this would be a tedious method and might be difficult to apply for the period of 45 to 60 minutes which would be necessary. Consequently, we chose to determine the concentration of gas in different parts of the tent by entomological rather than by chemical methods. This was done by determining the killing effect on insects placed in different parts of the tent.

Likewise the relation of the shape of the tree to the dosage was determined by a series of experiments in which the same amount of gas was generated under two tents representing the extremes in shape.

Form "trees" were constructed over which were placed ordinary fumigation tents of 8 ounce U. S. A. duck. The dimensions of the two trees were 31 ft. x 31 ft. and 22 ft. x 44 ft. They were thus fair sized trees, and the conditions were practically normal, excepting that there was no foliage under the tent. This point, however, has no bearing on the results, for comparatively the same conditions prevailed in both

[1] Paper No. 48. University of California, Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, California.

tents. In the high tent the insects were placed in the center, one foot from the top, and one foot from the bottom. In the low tent they were similarly placed at the top and bottom, but not in the center. The gas was generated by the pot method.

Following is a summary of the experiments:

FIFTY-TWO EXPERIMENTS—BEAN WEEVIL (*Acanthoscelides obtectus*)

Dosage, 5–20 oz. Exposure, 45–60 min. Tent temperature, 13°–24°C.

High tent 31 x 31			*Low tent 22 x 44*		
Place in tent	Number Insects	Killed (Percentage)	Place in tent	Number Insects	Killed (Percentage)
Top	237	65.8	Top	233	83.7
Center	237	70.8			
Bottom	231	35.5	Bottom	225	55.5
Totals	705	57.5	Totals	458	69.8

TWENTY-TWO EXPERIMENTS—GRANARY WEEVIL (*Calandra granaria*)

Dosage, 6–15 oz. Exposure, 30-60 min. Tent temperature, 17°–27°C.

High tent 31 x 31			*Low tent 22 x 44*		
Place in tent	Number insects	Killed (Percentage)	Place in tent	Number insects	Killed (Percentage)
Top	104	45.4	Top	105	47.6
Center	103	36.89			
Bottom	102	5.88	Bottom	105	19.04
Totals	309	26.5	Totals	205	33.3

TWENTY-SIX EXPERIMENTS—BEAN WEEVIL

Sulfur, 1–7 oz. and Cyanide, 2–7 oz. Exposure, 50 min.

High tent			*Low tent*		
Place in tent	Number insects	Killed (Percentage)	Place in tent	Number insects	Killed (Percentage)
Top	125	63.2	Top	113	62.0
Center	115	56.0			
Bottom	113	34.6	Bottom	107	44.0
Totals	353	54.1	Totals	220	57.7

TWENTY-ONE EXPERIMENTS—BEAN WEEVIL

Dosage, 10–18 oz. Exposure, 30–90 min. Temperature, 8°–24°C.

High tent			*Low tent*		
Place in tent	Number insects	Killed (Percentage)	Place in tent	Number insects	Killed (Percentage)
Top	120	90.0	Top	120	90.0
Center	120	85.0			
Bottom	120	75.0	Bottom	120	83.0
Totals	360	83.3	Totals	240	86.6

The query stated at the outset seems to be answered by the results of the above experiments, also the difference in killing efficiency between very high and very broad trees. In every case the high and the

low tents were charged at the same time, thus insuring a similarity of climatic conditions. The tents were of the same material and in the same condition, but as an additional precaution, they were interchanged.

The locations of the highest percentage killed are in the following order: Top of low tent, center of high tent, top of high tent, bottom of low tent, and bottom of high tent. With the exception of one set of experiments, more were killed in the top than in the center of the high

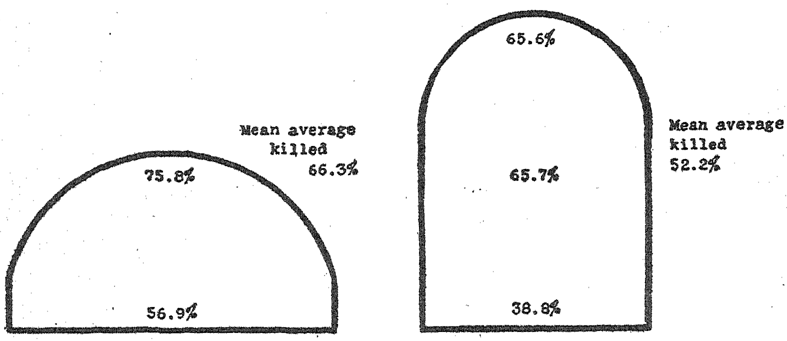


Fig. 11. Represents the summary of 121 experiments in which 2,873 insects were used showing the percentage of insects killed in different parts of the high and low tent and the mean average killed in each tent. The mean average of the high tent excludes the results in the center of that tent because no insects were placed in the center of the low tent, hence a more equable comparison.

tent, while in the totals there is a difference of only one-tenth of 1 per cent. While the difference in killing efficiency of the gas is not great between the center and top, there is a very great discrepancy between these locations and the bottom of the tent, a difference as shown in these experiments of 26.9 per cent. Likewise between the top and bottom of the low tent there is a difference of 18.9 per cent, and between the two tents there is a difference of efficiency, in favor of the low tent, of 19.4 per cent.

The fact that hydrocyanic acid gas is lighter than air, must account for a greater concentration accumulating in the top of the tents. The fact that the percentage killed is greater in the low than in the high tent, must be accounted for through the dosage schedules now in use, which do not adequately allow for the variation in the shape of the trees. We are not at this time, however, proposing any change in the schedules in practical use. Further extensive field experiments rather than laboratory calculations, must be the final test for any system of scheduling dosage. From the experiments here recorded which are field tests, the statement appears to be justified that our present

schedules are not correctly calculated for trees of extreme shapes. But from field experience, we are also aware of cases of unsatisfactory results on the insects with low broad lemon trees, and, on the other hand, complaints of too much injury to the tree in the case of tall orange trees. The discrepancy in our present dosage schedules for trees of different shapes has been pointed out by Woodworth, and he has proposed new schedules.[1] These schedules differ from the ones now in use chiefly in the fact that the larger trees receive a greatly increased dosage. This increase amounts in some cases to as much as 40 per cent, which dosage, the writer believes, cannot be used with safety to the trees in general practice.

TABULATION OF DATA CONCERNING THE FORM "TREES" USED IN THESE EXPERIMENTS

	High Tree 31 ft. x 31 ft.	*Low Tree* 22 ft. x 44 ft.
Tape circumference	31 ft.	44 ft.
Tent circumference	97 ft.	69 ft.
Tent surface	757 sq. ft.	380 sq. ft.
Ground surface	78.5 sq. ft.	154 sq. ft.
Total surface	835.5 sq. ft.	534 sq. st.
Volume	857 cu. ft.	717 cu. ft.

It will be seen from the table that the high tent is greater in volume by 140 cubic feet, and that the tent surface is greater by 377 square feet, the two factors that determine dosage. Consequently, the high tree should receive more cyanide than the low tree, but with our present schedules, these two trees receive the same amount of cyanide. This is partly because the basis of calculation is a geometrical figure corresponding to the shape of the tree, which does not take into account the variation in tent surface of differently shaped trees. The higher the tree, the greater, proportionally, is the tent surface when the tent is an octagonal sheet. The actual tent surface is determined by one dimension only, namely, the distance over the tented tree.[2]

In the high tree (31 ft. x 31 ft.) the circumference, as determined by the tape, or the geometrical figure, is 31 feet, but if the tape followed in and out of the folds of the same tent at the ground the distance would be 97 feet, or a difference of 66 feet. In the low tree (22 ft. x 44 ft.) measured in the same way, there is a difference of only 25 feet between the tape circumference and the actual tent circumference. Consequently, there is more tent area occupied by the folds in a tall narrow tree than in a low broad tree. Some of the folds may fit closely enough to prevent the entrance of much gas, but many of the folds

[1] Woodworth, C. W. New dosage tables. Cal. Agr. Exp. Sta. Bull. 257, p. 10–15. 1915.

[2] Morrill, A. W. Fumigation for the citrus white fly. U. S. D. A. Bur. Ent. Bull. 76, p. 39. 1908.

will be loose enough to allow the gas to diffuse between them. Thus the leakage surface is greater, and, moreover, the actual cubical contents is increased beyond that based on the measurement of a tight tape drawn around the tented tree.

The following "tent data" are presented to show the calculations for trees of widely different shapes. Examination of the table will show such variations as have already been alluded to in the case of the two trees mentioned, as well as further data regarding the surface of the geometrical figure, the ground surface, the relation of tent surface to volume, and the relation of dosage to tent surface and volume.

Tent Data

	Size tree	Dose[5] 100%	Tent[1] surface	Tent[2] volume	Rel. of dose[5] to surface and volume			Ground surface	Surface of[4] hemisphere and cylinder	Ratio of tent surface to volume	
					Surface		Volume				
a	10 x 16	3 oz.	79 sq. ft.	55 cu. ft.	1 oz. to	26 sq. ft. to	18 cu. ft.	20 sq. ft.	64 sq. ft.	1 to	.701
b	14 x 20	3	154	131	1	51	43	31	103	1	.851
c	16 x 28	4	201	248	1	50	62	62	153	1	1.232
d	18 x 36	5	254	394	1	51	79	103	206	1	1.542
e	20 x 24	4	314	300	1	78	75	45	187	1	.954
f	20 x 40	6	314	540	1	52	90	127	254	1	1.167
g	30 x 30	7	707	765	1	101	109	71	368	1	.541
h	30 x 40	9	707	1,176	1	78	131	127	454	1	1.665
i	30 x 60	13	707	1,850	1	54	142	286	572	1	2.618
j	34 x 50	13	908	1,950	1	69	150	198	622	1	2.147
k	38 x 40	11	1,134	1,686	1	103	153	127	614	1	1.486
l	38 x 64	18	1,134	3,188	1	63	177	325	834	1	2.811
m	40 x 50	15	1,257	2,546	1	83	170	198	773	1	2.026
n	40 x 60	18	1,257	3,396	1	70	189	286	873	1	2.704
o	42 x 44	14	1,385	2,259	1	99	161	154	748	1	1.631
p	44 x 68	22	1,520	4,492	1	69	204	367	1,076	1	2.954
q	45 x 60	20	1,590	3,971	1	79	198	286	1,022	1	2.497
r	49 x 54	25	1,886	3,878	1	75	155	232	1,058	1	2.056
s	49 x 68	25	1,886	5,413	1	75	216	367	1,245	1	2.870
t	50 x 60	23	1,963	4,687	1	85	203	286	1,172	1	2.336
u	50 x 76	76	1,963	6,461	1	67	223	459	1,375	1	3.290

O = Distance over.
C = Circumference.

[1] $O^2 \times .7854$.

[2] $\frac{C^2}{4\pi}\left(\frac{O}{2} - .144\right)$.

[3] $C^2 \times .07958$.

[4] $\frac{C^2}{2\pi} + \frac{CO}{2} - \frac{C^2}{4}$.

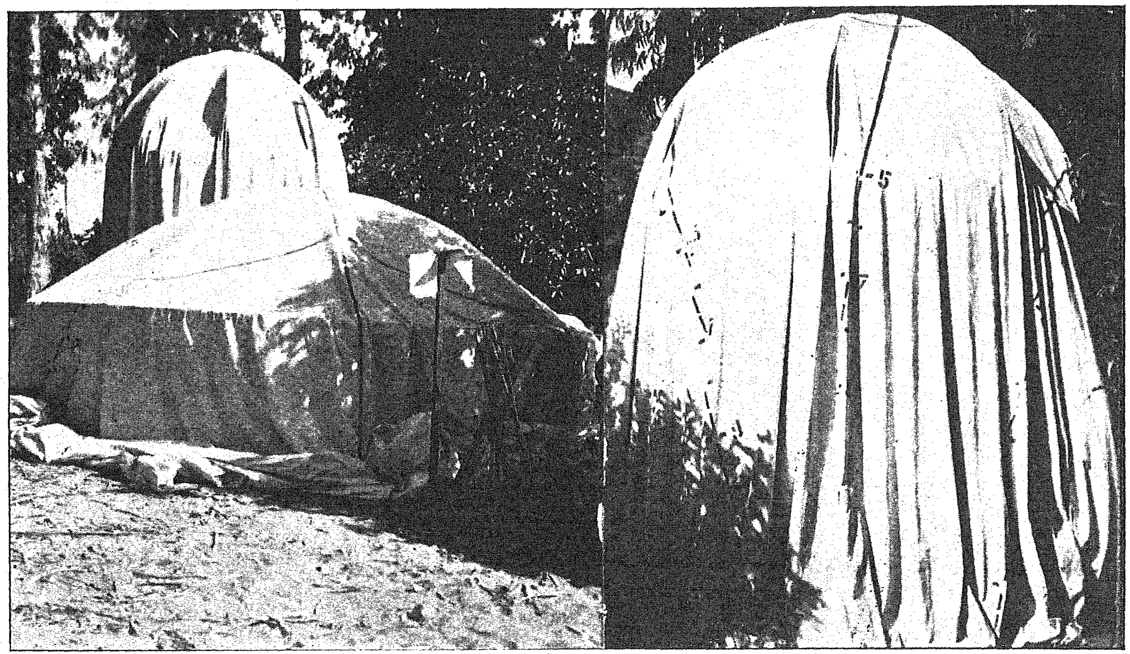
[5] On basis of 100% schedule now in general use.

Summary

The greatest concentration of hydrocyanic acid gas occurs in the upper half of tented trees.

The difference in the effect on insects at the top and bottom of a tree may be great enough to seriously impair the results. Little difference in gas concentration has been indicated by our experiments between the top and center of the tree.

Better killing of insects was secured in the low tent (22 ft. x 44 ft.) than in the high tent (31 ft. x 31 ft.). The actual difference was 19.4 per cent. These tents represent the most extreme shapes in citrus trees.



On the left are the two tents, representing the extremes in shape with which our experiments were carried on. On the right is a closer view of the high tent which shows the larger number of folds as compared with the low tent on the left.

Proportionally, there is more tent surface, and also volume, in a tall tree than a broad tree, and this is not indicated by the tape measurement around the tree, or by considering the tree as a fixed geometrical figure.

For practical consideration, the tall tree may well show more or less injury at the top to insure the insects being killed at the bottom.

PRESIDENT G. P. WELDON: Discussion of this paper is now in order.

R. S. WOGLUM: From observations in the field where the trees were more or less severely injured at the top, I am surprised that your experiments showed the same killing at the top as at the center.

H. J. QUAYLE: I think as a general rule there is a greater concentration of gas at the top than at the center of the tree, but that point was not brought out clearly in the particular experiments in question.

D. D. SHARP: I have seen some instances where the scales were not killed at the top of the tree, though it is a very common observation that more injury occurs at the top of the tree than elsewhere.

J. D. NEULS: In experiments in the fumigatorium, plants at the top of the fumigatorium seemed to be more injured than at the bottom.

PRESIDENT G. P. WELDON: The next paper is on "The Effect of Petroleum Oils on Mosquito Larvæ," by S. B. Freeborn and R. F. Atsatt.

THE EFFECTS OF PETROLEUM OILS ON MOSQUITO LARVÆ[1]

By STANLEY B. FREEBORN and RODNEY F. ATSATT,
University of California, Berkeley, California

To the layman, mosquito control immediately suggests oiling for since Dr. Howard's pioneer publications on the subject in 1892, the literature has been flooded with recommendations for the application of oil in order to control mosquitoes. Very few of these accounts suggest what grade of oil to use or the actual effect of the oil on the larvæ with the result that we have widely conflicting accounts of the amount of oil necessary to adequately control a given area, varying data on the time required for the oil to kill the larvæ, and no thoroughly satisfac-

[1] The authors wish to acknowledge the helpful suggestions and kindly criticism of Prof. George P. Gray of the University of California.

tory explanation of the principles underlying its use. The public gradually drifted into the impression that the oil killed the larvæ by suffocation brought about by the formation of an impenetrable layer of oil on the surface through which the larvæ were unable to thrust their breathing tubes to get oxygen. With this idea in view most of the recommendations were based on the purely mechanical problem of getting an oil that would spread easily and be fairly permanent. It has been the practice of the entomological division at the University of California to recommend a half and half mixture of crude oil and kerosene which would form an oil having a Baumé reading of 28° to 32° and which was found to answer the mechanical requirements mentioned above. It was our idea to check this recommendation with laboratory methods to determine if possible if any other oils would be better suited for the purpose.

In order to determine an ideal oil it was necessary to know first how the larvæ were actually killed and this paper takes up that phase of the problem. Various suggestions have been advanced, and in order to satisfy ourselves and reach a conclusion of our own we attempted to check up these different theories.

In all our experiments the mosquitoes used were the full grown larvæ of *Culiseta incidens*, a common culicine mosquito of California that is widespread throughout the state and to be found breeding in situations of varied character.

The oils used were a series of standard commercial oils of California origin. Their trade names and Baumé readings were as follows: Crude, 15.4°; low grade stove distillate, 29°; high grade stove distillate, 33.3°; commercial engine oil distillate, 38.5°; kerosene, 39.7°; gasoline, 55.5°; and a by-product with a Baumé reading of 20.3°, called "still bottoms," a residuum obtained from the stills after distillation. Besides these so-called toxic petroleum oils we used a standard brand of the non-toxic liquid petrolatum of 27° B.

The several theories, including our own, which have been advanced in explanation of the lethal action of the petroleum oils upon the mosquito larvæ may be summarized as follows:

(1) The physical properties of the oil layer are such that the surface tension is "annulled" to the extent that the larvæ are unable to hold themselves to the surface for the necessary breathing period.

(2) The layer of oil acts as a definite mechanical barrier between the larvæ and the outside air and thus leads to their ultimate suffocation.

(3) A portion of the oil or some of its dissolved or suspended material goes into solution in the water and poisons the larvæ.

(4) The oil in entering the siphon and tracheal tubes blocks them and effectually impairs respiration.

(5) The oil on entering the siphon and tracheæ acts as a contact poison through a direct action on the tissues.

(6) The theory which we will endeavor to prove in this paper is that it is the oil vapor from the inspired oil through its extremely rapid penetration of the tracheal tissues, which produces the marked lethal effects.

(1) Surface Tension

Ross in 1911 suggested that the oiling of a water surface so changed the physical conditions that the "larvæ are no longer able to keep the surface by surface-tension and quickly drown." In all our observations in this laboratory we have noticed a marked contradiction to this theory in that the larvæ under a film of oil are very prone to remain at the surface for considerable lengths of time, either in a quiescent condition or in what seems a definite struggle to pierce the film. It is very true that in a small shell vial with a steep meniscus, the larva under a film of oil is unable to hold his relative position on the meniscus, but continually slides toward the apex of the concavity, but when the meniscus is less steep, there seems to be no difficulty in maintaining the position at the surface.

(2) Suffocation

Celli (1904) in discussing the various larvicides states that petroleum oils exert "a mechanical action only, that is, by intercepting the air from the larvæ." A simple experiment was conducted by us in which this theory was tested. Larvæ were placed in several tubes with equal volumes of the same water and a previously moistened small cotton plug introduced into each tube until the water rose a short distance above it. Thus an effectual mechanical obstruction was introduced between the larvæ and the surface air which could have no other effect than that for which it was intended. At the same time, larvæ were placed in the same volume of the same water and a thin film of kerosene poured on the surface. The rapid death of those larvæ under the kerosene (45 minutes) as compared with those which were kept from the air through a simple mechanical means (30 hours) shows clearly that since the time required for uncomplicated suffocation was so much greater than that which is required for death under a layer of oil, the possibility of suffocation is but a slight factor in the larvicidal action of the oils.

Another set of larvæ in tubes containing equal volumes of water were covered with films of the various oils in the series with which we

were experimenting. If there were none other than the "mechanical barrier" action on the part of the oils, all of these larvæ should have died at the same time. On the contrary, however, we find a great difference in time, ranging from 45 minutes under the kerosene to 3 hours under the crude oil.

Somewhat along this line McFie gives the account of an experiment in cutaneous respiration wherein he kept totally submerged larvæ of *A. calopus* alive for over twenty days, the only necessary factor seeming to be that the water should be running slowly. The evidence, therefore, seems quite sufficient for discarding the suffocation theory.

(3) Poisoning through Aqueous Solution

The idea that some portion of the oil may be dissolved or suspended to a slight extent in the water in which the larvæ are living and thus produce the toxic effects has been suggested.

In our experiments we proceeded somewhat as follows: A quantity of boiled water was placed in a large funnel, covered with a deep layer of kerosene and allowed to stand for four hours. At the same time, an equal volume of the same water was tightly sealed in a glass jar. At the end of this period the water that had previously been treated with kerosene was drawn off from the bottom of the funnel without disturbing the oil film and placed in equal amounts in six vials. Equal volumes of water were drawn from the sealed bottle of untreated water and placed in corresponding vials. One larva was introduced into each of the twelve tubes and the water was then sealed with hot paraffin. The average length of time during which the larvæ survived in the normal water was 25⅓ hours and the corresponding period for those in the kerosene treated water was 25½ hours showing rather definitely that the solubility of kerosene in water is not a toxic factor in the killing of larvæ by its application to the medium in which they live.

Quoting again from McFie in an experiment where he used *Mansonioides africanus*, a type particularly adapted for the purpose through its faculty for cutaneous respiration and its subsequent habit of remaining on the bottom of the container we find "a larva was kept in a jar of water to the surface of which crude kerosene . . . had been added. For three days it appeared to be unaffected and on the fourth day it pupated" thus showing no ill effects of the oil on the surface.

From these accounts it may be concluded that the efficiency of the kerosene as a larvicide is independent of its solubility in the water.

(4) Blocking of the Tubes

The effectual suffocation of the larva through the entrance of the oil into their siphons and the actual physical blocking of the tubes by its presence has been suggested by Ross (1902).

In experiments in which we allowed the mosquitoes to draw into their tracheal systems repeated doses of the oil, which we had previously colored with Sudan III, an oil soluble stain not soluble in water, we found upon dissection that the oil had thoroughly penetrated even to the finest branches of the tracheæ and had through its viscosity and capillary action almost completely collapsed the delicate walls of the larger tracheæ. In the smaller division of the respiratory system the intermingled drops of oil and bubbles of air filling the whole diameter of the tube could be plainly seen. There can be no doubt that the oil, no matter whether a light oil such as kerosene, or a heavy oil-like liquid petrolatum does flow into the anal siphon, the main tracheæ and into even the very finest subdivisions, and does this in sufficient quantity to completely block them and render the passage of air impossible.

Here we must preclude, too, any possible application of the suggestion of Schafer, concerning terrestrial insects, that it may be possible for them to continue to breathe after having inhaled a quantity of kerosene or other oils, due to the penetration of the oil by the respiratory gases, for in our experiments the mass of the oil is without question too great.

We will agree then that this form of suffocation of the larva, due to an effectual plugging of the tracheal tubes by the inspired oil, could be considered as a very potent factor in the efficiency of the larvicide if time were allowed for this mode of killing to take place. One set of larvæ which were shut off from the air surface by a layer of paraffine and another set which were shut off from the air by inhaling a quantity of non-toxic petrolatum which plugged their tracheæ, were found to live for approximately the same length of time, while larvæ with petrolatum and kerosene in their respiratory tracts showed a decided difference, the kerosene producing lethal effects in 45 minutes while the non-toxic petrolatum required $4\frac{1}{2}$ hours.

As a further check upon this series of experiments and to show that the more rapid penetration of the kerosene into the tubes of the larvæ as compared with the slower penetration into the tracheæ of the heavier oils was not the primary cause of the difference in toxicity, it was repeated using the non-toxic petrolatum and a toxic petroleum oil of the same viscosity, and here again the toxic oil produced a much earlier death than the non-toxic petrolatum.

(5) The Oils as Contact Poisons

As we have shown above, by the use of our colored oils, these substances actually flow into the trachea and even into the very finest branches of the respiratory system, so that we have here a splendid basis for the conclusion that the oil in its close relation to the body

tissues of the larva would cause death by actual contact. Undoubtedly this factor of toxicity of the oils would suffice amply for the killing of the larvæ if sufficient time were allowed for it to act, but when a set of larvæ were treated with different oils, stained with Sudan III, in each case, except with the petrolatum and the crude oil, the larvæ were dead from an hour to two hours before the oils had penetrated the tissue as shown by the presence of stain in the microscopical examination. The oil enters and spreads throughout the tracheal system with great rapidity, but the larvæ, in our experience, are always dead long before the oil penetrates the tissue.

Shafer (1911) showed that in terrestrial insects treated with kerosene, penetration of the tissue required between three and twelve hours and concluded that death from treatment with kerosene resulted long before the liquid, as such, had time to penetrate the body.

Our next experiment gave further basis for this conclusion.

(6) The Oil Vapors as the Toxic Agents

Sen in 1914 reported a single experiment in which a few drops of kerosene were applied to a cotton plug in a bottle of water containing larvæ. He does not positively announce their early death as being directly caused by the vapor, but intimates that it is possible.

McFie (1917) repeated this experiment with different species of larvæ but remarks that its "action (the vapor) is less constant and much slower than that produced by a film of oil." It seems only reasonable to assume that the results would be much slower in this type of exposure than with a film of oil for with the film method the oil and its attendant vapors are brought in undiluted and direct contact with the respiratory tract, but when the oil vapors pass off from the saturated cotton in the vapor experiment they reach the larvæ in an indirect manner, highly diluted with air.

Since with our series of oils the lethal effects of the various grades corresponded very closely with the curve of their boiling points, we were led to believe that the volatility of the oils was the true index for their larvicidal action. With this point in view, we subjected our group of oils to the following experiments.

We placed samples of the series in small straight sided open pans and exposed them to a temperature of 28° C. ± 2°, in a constant circulation of air with the result that at the end of 103 hours the oils had evaporated to the following extent:

Kerosene	98.8%
Eng. distillate	85.2%
High grade stove distillate	35.4%
Low grade stove distillate	10.6%
Residuum	6.5%
Crude	.9%

We then used these evaporated residues to make the films in the usual manner and found that the practical toxicity or lethal effect of the oils had decreased in proportion to the percentage of the weight lost through evaporation, in other words, kerosene, previously giving rise to the greatest "lethality" had become the least efficient in its larvicidal properties which seemed to indicate that the loss of the volatile constitutents brought about a decreased toxicity.

Having obtained this data, we proceeded with a very definite check. Using shell vials of 2 x 5 cm. size, we placed several larvæ in equal volumes of their natural medium in each vial. Plugs of absorbent cotton were then introduced into the neck of each vial and on them were poured 3 cc. of the various oils, the lighter ones being colored with Sudan III in order to ensure the detection of any oil that might run down the inside of the vial to the surface of the water, and the vials corked up and sealed. A check, consisting of a similar vial containing larvæ, but to whose cotton plug there was applied no oil, was also used.

The results were as follows:

Vapors confined in chambers above water	*Average time required to kill larvæ*
Gasoline	153 minutes
Kerosene	185 "
High grade stove distillate	254 "
Low grade stove distillate	20 hours
Residium	*72 "
Crude	*72 "
Water vapor only (check vial)	*72 "

This experiment established the point that the vapors of the various volatile petroleum oils were toxic to mosquito larvæ even in dilute quantities when there was no possibility for the oil as a liquid to come in contact with them. As the curve of the time required to kill the larvæ in this experiment coincides with the curve of their volatility, the most volatile killing in the shortest time and also to the curve of the time required to kill when the oils were applied as films to the surface of the water, we feel justified in saying that the practical toxicity of the petroleum oils increases with their volatility. Of what these volatile products consist we are unable to state at this time.

We might call attention also to the fact that although we have suggested that volatility (a physical characteristic) may be taken as an index for the practical toxicity of the petroleum oils when used as larvicides, it must be borne in mind that the toxicity is entirely due to the chemical characteristics of the oils which vary with almost

* No apparent ill effects at end of 72 hours.

every distillation. Hence volatility as a factor in the toxicity of the oils enters into consideration because it serves as a measure of the amount of gaseous material given off in a given time and because the more toxic chemical constituents seem to be contained in the volatile fractions of an oil.

Although in all the petroleum oils having a boiling point below 250° C. the volatile constituents of the oil produce the lethal effects, those with the higher volatility producing the most marked and rapid results, in the oils having a boiling point higher than 250° C., the effects of the volatile constituents which are practically negligible in quantity may be overtaken by the effects of stoppage, actual contact, and even suffocation.

Moore (1917) working with terrestrial insects states that in volatile organic compounds the toxicity is correlated closely with the volatility but that a decreasing volatility is accompanied by an *increased* toxicity.

This would seem to be in direct contradiction to the results of our experiments but closer consideration of his findings suggests that the apparent discrepancy may be explained upon a difference in interpretation of the word "toxicity." From his point of view, a laboratory measurement of the total content of toxic elements was desired and possibly in no case was a saturated atmosphere of the chemical obtained. On the other hand, we were working to determine the toxicity of the oils under field conditions and in all our experiments we used a saturated atmosphere. In short, our object was to determine the oil which would give off the largest quantity of toxic material in the shortest length of time, while the experiments of Moore were designed to show the toxicity of definite amounts of the different chemicals exposed for a given period and confined in a given volume. Thus our standards of comparison were based on an entirely different viewpoint.

Again his results with petroleum oils seem hardly justifiable for his results are tabulated and his curves plotted in gram-molecules, *i. e.*, the molecular weights expressed in grams. Owing to the present impossibility of establishing the molecular weight of the petroleum oils it is difficult to conceive of an accurate measurement of these oils in gram-molecules.

In a later publication (1918) Moore tests out the toxicity of kerosene, again with terrestrial insects; but in some cases at least, using saturated atmospheres and concludes that "low boiling point fractions (highly volatile) are more toxic to insects in the form of vapor than high boiling point fractions due to the slight volatility of the higher fractions." He adds to this statement that "high boiling point compounds are more toxic than low boiling point compounds when used as contact insecticides in the form of an emulsion."

Inasmuch as we are confident that the oil vapors are the primary cause of death in the larvæ we feel that despite Dr. Moore's previous apparent disagreement with our findings this later publication seems to be in perfect accord with our results.

Conclusions

(1) The toxicity of the petroleum oils as mosquito larvicides increases with an increase in volatility, the more volatile oils producing the more marked lethal effects.

(2) The volatile constituents of the oils contain the principles that produce the primary lethal effects.

(3) The lethal effects are produced by the penetration of the tracheal tissue by the volatile gases of the oils.

(4) In the heaviest and least volatile oils (those having a boiling point greater than 250° C.) this action may be supplemented or apparently secondary to the effect of actual contact of the oil with the body tissue or perhaps to mechanical means such as suffocation or plugging of the tracheæ.

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President G. P. Weldon: Discussion of Mr. Freeborn's paper is now in order.

R. W. Doane: Do you find that the action of the valves of the anal siphons have any effect upon the manner by which the oil enters the tracheæ?

S. B. Freeborn: We have noticed repeatedly, when using stained oils, that the oil seems to pass into the anal siphon around the valves even though they be apparently tightly closed.

R. S. Woglum: Did you determine how long the oil of the different grades would remain on the water?

S. B. FREEBORN: We have not as yet conducted any evaporation experiments on films of water but we know from experience and from the results of our evaporation trials with different grades of oils that both temperature and air circulation have a marked effect upon the rapidity with which the oil disappears. In the case of our evaporation experiments we determined that a fan which kept the air in circulation in the incubator was responsible for 83 per cent of the evaporation for whenever the fan was shut off the evaporation decreased that percentage for the time the fan was out of commission. I should imagine from these results that air circulation would be a very potent limiting factor in nature.

G. P. GRAY: I am very glad to see articles on the use of petroleum oils appearing in the publications for it seems to me that work with this group will produce very satisfactory results for insecticide development. Much of the work yet to be done must be along chemical lines for although the physical characteristics act as indices and may augment or detract from the final toxic effects, it is after all the chemical constituents that actually do the work.

PRESIDENT G. P. WELDON: I will next call for a paper entitled "Notes on the Beet Leafhopper," by H. H. P. Severin and W. W. Thomas.

NOTES ON THE BEET LEAFHOPPER, EUTETTIX TENELLA BAKER

By HENRY H. P. SEVERIN, Ph. D., *California Agricultural Experiment Station* and WILLIAM W. THOMAS, M. S., *Spreckels Agricultural Experiment Station*

Ball [1] accounts for swarms of *Eutettix tenella* in the sugar beet fields of Utah in the spring of 1915, "by flights from the serious California outbreaks of 1914. This would involve the crossing of chain after chain of mountains and traveling from 600 to 800 miles in an air line."

In California, Ball found the leafhoppers breeding in abundance on the native Atriplex in the Lake Tulare region. He writes, "This district extends down as far as Bakersfield and the same conditions are probably repeated in suitable areas in the Mojave Desert and Death Valley sections. The leafhoppers were found commonly in the Imperial Valley, and it is probable that this whole region is within the permanent breeding grounds and is the source of the California troubles."

[1] Ball, E. D., 1917. Utah Agr. Exp. Sta. Bull. 155.

Although the senior writer was engaged in a study of the anatomy and histology of the internal organs of *E. tenella* as a foundation for the life cycle of the causal organism of curly-leaf of sugar beets if such occurs in the insect, we considered it our patriotic duty to temporarily abandon this phase of the problem, and spend a considerable amount of time in the field during the period of the war. Since Ball believes that the beet leafhopper breeds in arid or desert regions, and that the migration of enormous numbers of this pest have caused three serious and widespread outbreaks of curly-leaf in California and one in Utah in 1915, from flights of the California outbreaks in 1914, an investigation was started to determine where this insect spends the winter and to locate the breeding areas in this state. He states, "Any information by which the probable occurrence of these periodic outbreaks could be foretold would, therefore, be worth millions of dollars to this industry."

Trips have been taken into the San Joaquin Valley, to the Tulare Lake and Bakersfield district, Salinas Valley, Mojave Desert, Death Valley, Imperial Valley and to sugar beet fields in various parts of the state. After a general survey of the enormous territory, it soon became evident that it would require several years of field work before definite conclusions could be drawn in regard to the breeding areas of this insect. We shall, therefore, confine our attention to the results so far obtained in the Death Valley and Imperial Valley.

Death Valley

On January 27–31, a trip was taken into the Death Valley and sweepings were made on desert vegetation from Ryan to Keane Wonder, a distance of thirty-eight miles, and on cultivated vegetation at Furnace Creek ranch situated about midway between the two towns. No *E. tenella* were captured on desert vegetation; such as cattle spinach (*Atriplex polycarpa*), desert holly (*A. hymenelytra*), alkali blite (*Suaeda moquini*), creosote bush (*Larrea divaricata*), mesquite (*Prosopis juliflora*) and other undetermined plants. No beet leafhoppers were caught on salt grass (*Distichlis spicata*), Kern greasewood (*Spirostachys occidentalis*) and salt rush (*Juncus leseurii*) growing near the margin of the salt marshes. No specimens were taken on mesquite, arrow-wood (*Pluchea sericea*) and Bermuda grass (*Cynodon dactylon*) growing along Furnace Creek. No hoppers were captured under cultivated conditions at Furnace Creek ranch on alfalfa, cheese weed (*Malva parviflora*), nettle-leaf goosefoot (*Chenopodium murale*), Bermuda grass, and on arrow-wood and Bermuda grass growing along the irrigation ditches. If we are justified in drawing conclusions from the investigations carried on at this time of the year, apparently *E. tenella*

does not occur on desert vegetation from Ryan to Keane Wonder and in the cultivated area at Furnace Creek ranch in the Death Valley.

Imperial Valley

In view of the fact that the same territory must be covered repeatedly during a year, we have selected the Imperial Valley for more intensive work. Up to the present time the investigation has been carried on under desert and cultivated conditions and no attention has been given to the canyons, foothills and mountains.

Ball suggests that the flights of the beet leafhopper may be "in the nature of migrations northward in the spring and southward in the fall." If our interpretation of this statement is correct, we would expect to find the hoppers wintering over in the desert after their southward flight. Under desert conditions, however, only a few specimens were captured on the foliage of the following plants:

January 22, 1918, 3 *E. tenella* on gourd (*Cucurbita californica*), 4 miles west of Coyote Well near foothills.

March 10, 1918, 2 *E. tenella* on creosote bush (*Larrea divaricata*), 4 miles west of Coyote Well near foothills.

The beet leafhopper was extremely scarce at this time of the year on vegetation in desert areas within cultivated districts. Sweepings on desert vegetation in the vicinity of the Alamo River near Holtville, and the New River near Seeley and Brawley (Map[1]), and also on vegetation growing along the banks of these rivers, captured only an occasional specimen.

An investigation was made at the boundary between the desert and cultivated area. A glance at the map shows that a main irrigation canal marks the boundary between the desert and cultivated land on the west side of the Imperial Valley. Between the San Diego and Arizona railroad tracks and the State Highway, desert collecting was started about one mile west of Dixieland and continued to the irrigation canal but not a single specimen was captured. Near the irrigation canal and in recently irrigated fields over one hundred adults and thirty nymphs were collected on the lowland or sea purslane (*Sesuvium sessile*) on March 13–14. In the same vicinity a dozen hoppers were taken on Chinese pusley (*Heliotropium curassavicum*).

In January and March *E. tenella* was found in large numbers under cultivated conditions in all localities visited in the Imperial Valley on the Australian salt bush (*Atriplex semibaccata*), a native plant of Australia. During a hot sunshine, sweepings on this plant near Calipa-

[1] The map is one issued by the Automobile Club of Southern California. It was not reproduced. Ed.

tria, Brawley, Imperial, Dixieland, Seeley, El Centro and Holtville (Map) rarely failed to capture from one to fifteen adults. In taking the trip by stage to the various towns mentioned, the Australian salt bush was observed growing along irrigation ditches, roadsides, railroad tracks, fences and vacant fields. Several hundred specimens were captured on a half dozen patches of this Atriplex and yet day after day when these same plants were swept with an insect net, more and more bugs were obtained. In all probability, many millions of beet leafhoppers occur on this plant in the Imperial Valley.

Specimens of the Australian salt bush in the University of California herbarium show that the plant occurs in the following counties of California: Nevada, San Mateo, Los Angeles, Orange, Riverside and San Diego. In Orange County, three miles northeast of Huntington Beach, forty-two *E. tenella* were captured on Australian salt bush on January 21. A few specimens were also caught on *Malva parviflora* and *Chenopodium murale*. Several old beets showing curly-leaf were found in the same vicinity, although this disease has never been reported from Orange County on the authority of Professor R. E. Smith.

Hibernation. In the Imperial Valley the beet leafhopper cannot strictly be said to hibernate, understanding by that term the passing of the winter in a greater or less degree of torpor, without food. During the winter few specimens were captured during the early morning hours due to the sluggishness of the insects produced by the cold nights; also on cloudy days but few bugs were taken. That the adult hoppers do not undergo a fast during the winter is shown by the following experiments: On February 24, at 6 p. m., ten *E. tenella* were placed without food in a cage with top and sides made of sheer muslin. All died within 1½ days under field conditions at a maximum temperature of 86° F. and a minimum temperature of 42° F. This experiment was repeated, but the insects were placed in a cage without food at 8 a. m. Six died within ten hours and all were dead at the end of one day (maximum temperature, 84° F.; minimum temperature, 36° F.). In a similar experiment, ten specimens placed in a cage without food at 8 a. m. died within 1½ days (maximum temperature, 84° F.; minimum temperature, 34° F.).

Besides the plants already mentioned in this paper, *E. tenella* was captured on the foliage of the following plants in various localities in Imperial County:

Quail brush (*Atriplex lentiformis*), 3 miles south of Imperial, January 23, 1918.
Cattle spinach (*A. polycarpa*), 2 miles east of Dixieland, March 14, 1918.
Shad scale (*A. canescens*), Holtville, January 23; Niland, March 15, 1918.
Alkali blite (*Suæda moquini*), Niland, March 15; Dixieland, March 13, 1918.
Bermuda grass (*Cynodon dactylon*), 2 miles south of Imperial, January 23, 1918.

Tall pepper grass (*Lepidium medium*), 3 miles south of Imperial, January 23; Calipatria, March 15, 1918.

Cheese weed (*Malva parviflora*), Calipatria, March 15, 1918.

Poverty weed (*Iva axillaris*), Calipatria, March 15, 1918.

It may be possible that the beet leafhopper was not feeding on all of the plants listed, but that the vegetation simply served as a resting place. Near Manteca, on February 11, a single adult was captured on bamboo which served as a wind break. The foliage of bamboo was swept with an insect-net during an entire afternoon but not another specimen was taken.

During the winter in the Imperial Valley, nymphs of *E. tenella* were found on the lowland or sea purslane (*Sesuvium sessile*), Australian salt bush (*Atriplex semibaccata*) and nettle goosefoot (*Chenopodium murale*). Nymphs collected on the Australian salt bush at El Centro on January 22, transformed into adults on January 30. To determine whether eggs had been deposited on *Sesuvium sessile* and *Atriplex semibaccata* under natural conditions, pieces of the plants were shaken over a black back ground at intervals for several days so that there was no question of doubt that neither an adult or nymph was present on the vegetation. The plant was then placed in a card board box with a hole at one end opening into the mouth of a phial. For a period of ten days, nymphs hatching from eggs deposited in both species of plants were found in the phials.

Conclusion

In the cultivated districts of the Imperial Valley, *E. tenella* has been found in large numbers on the Australian salt bush (*Atriplex semibaccata*) in January and March, and the lowland or sea purslane (*Sesuvium sessile*) in March. The pest is breeding on these two plants under natural conditions. No complete hibernation occurs in the Imperial Valley.

We are deeply indebted to members of the botanical department of the University of California for the determination of the plants mentioned in this paper.

President G. P. Weldon: The next paper is entitled "Some Problems in the Control of Insects in Stored Foods in California," by R. W. Doane.

SOME PROBLEMS IN THE CONTROL OF INSECTS IN STORED FOODS IN CALIFORNIA

R. W. Doane, *Stanford University*

The critical situation in which we find ourselves at the present time, particularly as regards the food that we need for our allies and ourselves, strongly emphasizes the necessity of taking every step possible to prevent the loss of foods or food materials.

The entomologists have been keenly aware of the importance of insects in this struggle for food, and since the very beginning of the war have been trying to bring before those in authority and before the people in general the important facts bearing on this subject. As a rule we have met with a hearty response when we have called for action along certain definite lines, but we have also met with disappointments, for it is sometimes very hard to convince the uninitiated that things as small and lowly and despised as insects can play an important part in this great world war.

But when one finds a mass of flour and excrement matted together by the webbing made by the larvæ of the Mediterranean flour moth, or when one finds the dark ill-smelling flour beetles in the flour, or the weevils or their larvæ in the rice or beans or other food products, it is not hard to convince the observer that something is wrong, and all agree that something should be done to correct this disagreeable state of affairs.

Here in California where many insects breed throughout the year, we have paid but little attention to the insect pests of stored foods. Twenty-five years ago Prof. W. G. Johnson, at the time an instructor in Entomology in Stanford University, did a good deal of work with the Mediterranean flour moth in the mills around San Francisco Bay and a little attention has been paid to the larvæ found in stored fruit. But little other work has been done.

In a very hurried survey that we have made of about 100 warehouses and flour mills in Central and Southern California, while acting as consulting entomologist for the Federal Food Commission for California, we have found practically all of the common pests of stored foods in greater or less abundance. The Mediterranean flour moth is found in nearly all of the flour mills and is regarded by all as the most serious pest that we have to deal with in such places. The larvæ spin their silken threads wherever they go, and as they go everywhere, all of the machinery, the elevators and shoots, as well as the flour in the bins and sacks, become covered or filled with masses of webbing which cause no end of trouble for the miller.

The Mediterranean flour moth is also the most common pest of warehouses. In several instances we have seen hundreds of sacks of flour covered with the fine web that is spun by the larvæ as they wander about seeking a suitable place to pupate. These same sacks would be punctured with holes made by the larvæ as they came out and little heaps of flour on the sack indicated where other larvæ were working. In one warehouse nearly 1,000 sacks were thus seriously infested and about 2,000 other sacks showed only lighter infestation. The most seriously infested lots in the warehouse were those that had been in there for several months but one lot of nearly 500 sacks that had been in the warehouse only two weeks was heavily infested and the larvæ were issuing from the sacks in great numbers. This lot was, of course, badly infested before it came into the warehouse.

Fortunately the conditions in this warehouse were not typical of those found in most of the others visited. In one other instance we found 2,300 sacks of flour quite badly infested, but as a rule only smaller lots were found to be badly infested and in many warehouses we found very little or no infestation.

The rice weevil, *Calandra oryza* L., was found in great numbers in some warehouses and was present in smaller numbers in many other places. The heaviest infestation was found in a corner of an upper floor of a warehouse that was otherwise in fine condition. The beetles were first noticed crawling over sacks of flour stored near a window. Then it was found that the floor near this window was literally covered with the beetles and many were also found crawling over bags of imported rice in the end of the warehouse.

The source of this trouble was, after a long search, found to be a small, old, and evidently forgotten lot of rice stacked back of a larger lot that quite hid it. The bags were completely covered with the beetles and the floor and nearby bags of rice were also covered with masses of weevils that moved about slowly when the flashlight was turned on them.

In another warehouse little heaps of flour on a number of sacks indicated the presence of some insect. Further examination showed that inside the sack back of each of the little piles of flour, one of these rice weevils was working. A few holes were found showing where the weevils had issued from the sacks and some of them were found crawling about. Three lots of flour in different parts of the warehouse were found to be thus infested. Later it was found that these three lots, representing different brands of flour, had all come from the same mill and the source of the infestation will doubtless be found in the mill. Other lots of rice and a few lots of wheat were found to be infested with this pest.

The granary weevil, *Calandra granaria* L., was found in probably half of the warehouses visited, but usually only in small numbers.

The saw-toothed grain beetle, *Silvanus surinamensis*, is commonly found associated with this species and in some instances they both become very abundant and destructive. One warehouse that had suffered very severely from the attacks of these two pests in 1917, was still badly infested. Certain lots of waste grain and chaff were alive with these beetles and some of the large bins that were filled with barley were badly infested. As some of this barley was being moved from one bin to another it was passed over a screen and the screenings were found to consist largely of these beetles. In another instance all of the corn in a feed store was found to be badly infested with these two beetles. The confused flour beetles, *Tribolium confusum*, were found in nearly all warehouses and in some of the mills. Usually they were not present in great enough numbers to be of much importance but in some places they were causing much trouble and loss. They are general feeders, nearly all kinds of food products being attacked.

The rust-red flour beetle, *T. navale* Fab., was also found in a few places. Their presence gives the food a disagreeable, musty odor. Bread made from flour that has been infested with these beetles, has a disagreeable odor when first baked, but this all or nearly all disappears as the bread cools.

A few other moths and beetles, some of them as yet unidentified, and a mite, probably *Tyroglyphus longior* Ger., have been found in various cereals or cereal products in mills, warehouses, stores and private houses, but no attempt will be made to give a list of these now, as the inspections that we are still making keep bringing to light new and interesting forms.

We have found but a few instances of weevil infestation in beans, but when these occurred the loss was almost or quite complete. Adults of the third generation are now, March 25, appearing in lots of beans that have been in my laboratory since November.

But the important question of "What can we do about it?" is the chief concern of the miller, the warehouse manager, the storekeeper and the housewife, and of course therein lies our chief interest in these investigations.

Preventive measures are usually of first importance in dealing with any insect. In the case of these pests, particularly, too much emphasis cannot be placed on the importance of cleanliness and a careful watch of all incoming material.

Cleanliness will not always insure freedom from attack by the insect pests of stored products, but, in spite of certain notable exceptions, the rule holds that the amount and extent of the infestation bears a very

close relation to the degree of cleanliness about the mill or warehouse or store-room. Some of the best mills keep their machinery and floors and walls quite free from flour dust by using compressed air for cleaning out the cracks and crevices, blowing the dust out where it can be easily swept up by brooms. Others make a practice of treating their floors at regular intervals with gasoline or kerosene to destroy the larvæ and beetles and mites that accumulate in the cracks in all but the very best of floors.

Light is always a great factor in cleanliness and modern mills and warehouses are now built so that all parts of the house may be well lighted and of course daylight is preferable to any kind of artificial light. The claim is sometimes made that insects will not breed in food materials that are stood in light places. While it is true that insect pests are usually less common in such places, the rule is not a safe one in practice, for light does not altogether protect foods from infestation. Indeed, it seems that, while as a rule these insects prefer to work in dark places, they may under certain conditions, probably at breeding time, seek out the light. I have already referred to the swarms of rice weevils that had gathered to the light near a window, when the infested material from which they came, was near the middle of a long room with light only at the ends. Many other instances might be cited where not only the weevils but the moth larvæ were found in material stored in places where the light was good and strong.

Given a good, clean, light warehouse or mill, the careful manager will watch with unceasing vigilance everything that comes into his house. There are certain signs that usually betray the presence of insects to the careful observer, even when the food material is packed in sacks and boxes, and if there is any reason whatever for believing that incoming goods are infested, a careful examination must be made. Used sacks are particularly dangerous sources of infestation and should always be looked on with suspicion and thoroughly cleaned or fumigated before being admitted to the storeroom.

But in spite of all our care, infested materials may be carried into even the cleanest of places, or the adult insects themselves may fly or crawl in. In the same way some of the most important insect pests of our farms and orchards have escaped the watchful eye of the quarantine officer, and in both instances active control measures soon become necessary.

In a clean well lighted place, it is usually easy to detect the beginnings of an infestation which may be checked before it has spread far, but which, if left alone, would soon become of much more importance. A lightly infested lot of flour or meal may be sifted or rebolted and put in clean sacks with but little loss if the material is in a mill or can be

sent to one. If it is not possible to attend to this at once, or if it is necessary to move the infested material from one place to another, it is worth while to first clean the outsides of the sacks or other containers, in order that the insects may not be spread about in the moving.

The managers of some mills believe they have taken sufficient precautions to prevent the spread of the Mediterranean flour moth when they place infested lots of flour some distance away from other flour. One warehouse man told me that when he found any food stuffs infested with insects he always put a ring of hydrated lime around the infested lot to prevent the spread of the pest to other parts of the house. Another man was found to be using formaldehyde for fumigating a room badly infested with rice weevils and he could not understand why the beetles kept spreading.

Such "protective" measures are dangerous, not only because they do not kill the insects, but because they either give the experimenter a false sense of security or else he becomes discouraged and gives up altogether.

It is an easy matter for us to carry on a series of experiments with these insects, and to find that under certain conditions, that we have well under control, we can kill all or nearly all of the pests with which we are working. But as soon as we get out into the warehouses and mills, we begin to meet with serious difficulties. Let me give a concrete example: The warehouse previously referred to, where 2,000 or 3,000 sacks of infested flour was found, also had about 20,000 other sacks that were infested very lightly or not at all. This flour belonged to some twenty-seven different owners and was scattered throughout the warehouse. Stored with the flour, or close to it, was to be found many other kinds of food stuffs. Some of the owners of the flour believed that the warehouseman should fumigate his house and kill the insects, others objected because they were afraid that the flour or other foods might be injured by being fumigated.

The manager was told that the Board of Underwriters had said that anyone fumigating with carbon bisulphide would do so at his own risk, as his insurance would not cover the risk from fire if he had such materials in his house. On account of the danger to foodstuffs containing a great deal of moisture he could not use cyanide and the house was not tight enough for fumigating purposes anyway. There was no provision for heating the house by steam or otherwise. What should the poor man do? While he was seeking an answer to this question, the condition of the badly infested flour was called to the attention of the Pure Food Inspectors of the Bureau of Chemistry. They ruled that much of it was unfit for human food and the owners agreed to sell the most of it for stock food or for making paste for bill-posting purposes, and to reprocess the rest and thus save as much as possible.

This is only one, fortunately the worst one, of many troublesome cases we have had to deal with since beginning these inspections. As long as the insurance men refuse to take the fire risk when carbon bisulphide is used, I can only recommend the use of that important insecticide in small detached buildings or in places where no insurance risks would be involved. The managers of some mills and some warehouses tell us that they fumigate regularly with hydrocyanic gas, but often when talking with the foreman of such a place, we find that the work has not been done as often as reported and sometimes we find that it has really not been done at all. So it is very hard to get exact data on the amount of this work that is actually done. Those who are using this gas, or report that they are using it, say that they do not regard it as dangerous in mills or in warehouses where only cereals or cereal products are stored. But the Pure Foods Laboratory of the U. S. Bureau of Chemistry, when asked if there could be any danger from this source, ruled that there might be danger at least when other food products were present in the building.

Mr. De Ong, who has been associated with me in some of this work, planned to make a series of experiments in order that we might know definitely the answer to some of these questions but he is not yet ready to report.

We found only one mill where provision was made for using heat for fumigating. In this mill a small room, about 8 x 10 ft. with a 12 ft. ceiling, was provided with a large radiator and the miller told me that he could easily maintain a temperature there of 130° to 140° F. for several hours. In this room he places the infested packages of cereals that are sent back from the wholesalers and the retailers and subjects them to these high temperatures with the result that all the insects are killed. Materials only slightly infested can be reprocessed and the others can be used for stock food and the danger of the insects spreading over the mill is eliminated.

I have strongly recommended the construction of such fumigating rooms in many other mills and in some warehouses, where steam for heating was available. The room for such a purpose need not be a large one for if the lot of material to be treated is more than can be stood in the room at one time, it can be divided into small lots and the process repeated as many times as necessary.

The very interesting and important question as to whether the excretions of the insects, while they are in the flour or other food products, has any harmful effect on the food, keeps coming up constantly. It has been very generally assumed that if the insects can be removed the food will be perfectly wholesome. Few of us, however, can anticipate with any great pleasure the using of flour that has been infested

with any of these insects, even if it has been sifted or thoroughly rebolted before being used. The ordinary sifting removes all of the insects, at least all of the larger ones, but it unfortunately does not remove all of the fecal matter. Only rebolting will do this. Some believe that this fecal matter may contain enough poison to affect more or less seriously anyone using such contaminated flour. Others, and among them some prominent chemists and toxicologists, do not think any harm whatever could come from using bread made from even badly infested flour.

I am told that the results of some recent experiments seem to indicate that the poison, if any is present, may be due to the urates of the insects infesting the grain or flour. Cleaning the grain or sifting or even rebolting the flour would not remove the danger from this source, if it really exists.

This seems to be a subject worthy of further investigation and a chemist and an entomologist working together might be able to obtain some interesting and valuable results.

President G. P. Weldon: This paper by Professor Doane is now open to discussion.

R. E. Campbell: Is the HCN gas collecting in moist fruit products a real or an imaginary danger?

R. W. Doane: There seems to be some claim in fact for such a statement.

G. P. Weldon: How much material is necessary?

R. S. Woglum: Three ounces to 1,000 cubic feet has been recommended in a publication by Chittenden. Experiments carried on some time ago at Kansas Station included analyses and baking qualities of the product after fumigation.

G. P. Gray: I have gone into the records of the Kansas Station and as I recall there is no definite statement about flour absorbing HCN. While I believe there is no danger, still it is a matter that must be seriously considered.

H. T. Fernald: There would be a difference whether or not the product is cooked after fumigation.

R. E. Campbell: It seems to me there is possibility of developing in this connection insect proof containers.

H. J. Quayle: I am sorry that I did not hear all of the paper, but it seems to me the question of penetration is important in this connection, and as I understand it carbon bisulphide penetrates such material as grain and the like better than hydrocyanic acid.

G. P. Gray: The objection on account of danger of using carbon

bisulphide in warehouses might be overcome by having a special room constructed outside the warehouse.

R. W. Doane: I recommended such a course in the case of a warehouse I visited a few days ago.

President G. P. Weldon: The next paper in order is "Fumigation Experiments: The Time Factor," by A. F. Swain.

FUMIGATION EXPERIMENTS: THE TIME FACTOR

By A. F. Swain, *University of California, Citrus Experiment Station, Riverside, California*

Introduction

The control of the insect pests of citrus trees in California is accomplished largely by the use of hydrocyanic acid gas. As practiced at the present time, there is a considerable variety in the methods of procedure, and there are many problems on which further data are desirable. Among these is the determination of the proper time of exposure; whether the times in most common use, namely, 45 and 60 minutes, are the most practical; whether a shorter period would suffice or a longer period be more efficient; and whether there is any real difference in the efficiency between the 45 and 60 minute periods.

While carrying on some fumigation experiments for another purpose during the season of 1916–1917, the writer was impressed by the fact that there did not seem to be any constant and appreciable difference between exposures of 45, 50, and 60 minutes. However, as these experiments were not arranged for the determination of that factor, no certain results could be obtained therefrom. During the past season the problem again came up, and the writer made a few experiments in an attempt to add further data to the question. In this paper are given the results of those experiments, together with the results of actual commercial fumigation, as carried on in 125 groves in Tulare County during July, August and September, 1917, for the control of the citricola scale (*Coccus citricola*).

Experimental Fumigation

The necessary apparatus for the carrying on of these experiments consisted of the following. Two form "trees" of the same size and shape were used. These consisted of frameworks of such form that when covered with a tent they would approximate the shape of a fair-sized orange tree. Each measured 26 feet around by 31 feet over, which size requires, according to the schedules in use at present, a six ounce charge of sodium cyanide for the 100 per cent or full schedule. They were each covered with tents of the same size and material; namely,

45 foot, 8 ounce U. S. army duck. The ordinary earthenware fumigation pots and the form of sodium cyanide known as "Cyanegg" were used to generate the gas.

The methods of procedure were identical in each case. Small circular cardboard boxes (the common coverglass boxes), with the ends replaced with pieces of fine cheese cloth were used as containers for the insects. One was hung in each tent, about midway between top and bottom, and half the way from the center of the tent to the side. In those cases where red scale was used, the infested lemons were placed in a wire basket which was hung in the same position as the cages. The pot was set as near the center of the tent as possible, and the charge generated therein. Both "trees" were charged at the same time, although of course the insects from one were removed before those from the other. Although the "trees" were of the same size and shape, and the tents of the same material, the charges were alternated in each case in order to insure against any possible difference between them.

In many of the experiments during the past season adult lady bird beetles (*Hippodamia convergens*) were used as an index for the "killing efficiency." For many purposes these were more advantageous than scale insects, but as results with scale insects were wanted, they were used to verify the results obtained with beetles. The beetles were used because it was easy to determine whether or not they were alive, inasmuch as they are active insects; because this could be determined accurately within a comparatively few hours after fumigation; and because a considerable number of them could be obtained from the nearby mountains. All of the beetles used throughout the experiments were taken from two colonies in San Antonio Canyon near Camp Baldy. The main disadvantage with the beetles was the fact that they seem quite sensible to fluctuations in temperature. However, as each set was carried on at the same time and under identical conditions, this was immaterial. The scale insect used to verify the results with beetles, was the common red scale of citrus (*Chrysomphalus aurantii*) on lemons from the Hewes Ranch near El Modeno, Orange County.

In the experiments with the beetles four ounces of sodium cyanide were used in each charge, this being found sufficient to kill a large percentage of the insects. A complete killing in any case was not desirable. With the scale insects it was found that a 2½ ounce charge was sufficient, a 3 ounce charge sometimes making a complete kill. Inasmuch as these "trees" called for a 6 ounce dose at the full schedule, it must be noted that these experiments were carried on in the day time, and that these "trees" were not filled with foliage as is the case in the field.

The results of the fumigation work in Tulare County were obtained from reports by Commissioner C. F. Collins of Tulare County. Every year he has had an inspection made of each grove, and leaves collected from many of the trees, about a month or a month and a half after fumigation. The insects on these leaves are counted, the number present and the number alive being noted. As about 1,600 insects are examined from each ten acre grove, a fair estimate of the percentage killed is obtained. The figures in Table III were obtained from the 1917 report by Commissioner Collins.

TABLE I—*Hippodamia convergens*, NOVEMBER 19–23, 1917

Time of exposure	Number of lots	Number of insects	Percentage killed[1] Mean	Standard deviation	Percentage difference
60	10	632	97.47± .82	2.99± .58	
					11.00±2.53
30	10	702	86.47±2.39	8.67±1.69	
60	6	374	95.19±2.72	8.69±1.31	
					4.23±3.75
45	6	177	90.96±2.58	8.25±1.24	

These few experiments show a decided difference in favor of the 60 minute exposure over the 30 minute exposure. In ten lots, totaling 1,332 insects, the difference is 11.00±2.5 3per cent, which is fairly definite inasmuch as the difference (11.00 per cent) is more than four times as great as its probable error (2.53 per cent). However, in six lots, totaling 551 insects, the difference in favor of 60 minutes over 45 is but 4.23±3.75 per cent. This means that there is no real and constant difference, inasmuch as the probable error of the difference (3.75 per cent) is almost as large as the difference (4.23 per cent).[2]

After obtaining these results it was decided to repeat the experiments using lemons infested with red scale (*Chrysomphalus aurantii*) instead of the coccinellid beetles. Table II shows these results.

[1] The mean percentage killed is obtained by dividing the total number of dead insects by the total number used; $\frac{D}{T}=M$. The standard deviation (σ) is an index of variability and is obtained by the formula $\sigma=\sqrt{\frac{\Sigma\frac{D^2}{T}}{\Sigma T}-M^2}$. The probable error of the mean is an index of the reliability of the mean. It is obtained from the standard deviation and the number of experiments. The formula is $E_M=\pm 0.67449\frac{\sigma}{\sqrt{N}}$ (when N=the number of experiments).

[2] The probable difference between two means (A_1 and A_2) is: $A_1-A_2\pm\sqrt{E_1^2+E_2^2}$ (Davenport, C. B. Statistical Methods, p. 15, 1914). In the case of the 45 and 60 minute exposures it is therefore: $95.19\%-90.96\%\pm\sqrt{2.72^2+2.59^2}=4.23\pm 3.75\%$.

TABLE II—*Chrysomphalus aurantii*, FEBRUARY 19–20, 1917

Time of exposure	Number of lots	Number of insects	Percentage killed[3] Mean	Percentage killed[3] Standard deviation	Percentage difference
60	8	800	91.50± .36	1.50± .22	
					11.25± .77
30	8	800	80.25± .68	2.86± .43	
60	10	1000	96.30± .36	1.68± .26	
					0.40± .55
45	10	1000	95.90± .41	1.92± .29	
60	10	1000	87.30± .48	2.24± .34	
					0.30± .67
90	10	1000	87.60± .58	2.73± .42	

The experiments with the red scale as the index gave results quite comparable with those in which the coccinellids were used. Between 60 and 30 minute exposures there was a difference of 11.25±0.77 per cent which is comparable with that of the coccinellids; namely, 11.00±2.53 per cent. Between 60 and 45 minutes the probable difference was 0.40±0.55 per cent. In this case the probable error of the difference was larger than the difference, showing that there is no real difference. In addition to these, a series of experiments was carried on in which the exposures were 1 and 1½ hours, with the result that the difference in favor of the 1½ hour period was only 0.30±0.67 per cent. In other words there seems to be no advantage in an exposure of 1½ hours over that of an hour. Nor is there any higher efficiency obtained by an hour exposure than by a 45 minute exposure. There is, however, a decidedly higher killing efficiency obtained in 45 minutes than in 30 minutes. These experiments, therefore, show that at 45 minutes a killing efficiency is obtained which is not exceeded, by even twice that length of time.

COMMERCIAL FUMIGATION

To further verify these results, a study of the fumigation reports from Tulare County for the season of 1917 was made. Table III shows these results.

TABLE III—FIELD FUMIGATION, TULARE COUNTY, JULY–SEPTEMBER, 1917. *Coccus citricola.* 120 PER CENT SCHEDULE

Time of exposure	Number of orchards	Number of acres	Number of insects	Percentage dead
45	15	185	34,495	99.32
50	33	455	65,007	99.28
55	77	1225	192,908	99.21

[3] In determining the percentage of the insects killed only mature females were counted; the immature females and the males being omitted.

These counts show that there was no difference between the results obtained in actual field practise in Tulare County between exposures of 45, 50, and 55 minutes. The writer did not attempt to calculate the probable error and probable difference in these counts, as the percentage dead of the various exposures are so close that it is certain the probable error of the difference would be greater than the difference.

Summary

From a series of 44 experiments (using a total of 7,485 insects) carried on in the daytime under form "trees" covered with tents of 8 ounce U. S. army duck, with both coccinellid beetles (*Hippodamia convergens*) and red scale (*Chrysomphalus aurantii*), it was shown that an exposure to hydrocyanic acid gas for 30 minutes was not sufficient to obtain the highest killing efficiency. It was shown, however, that with 45 minutes as good results were obtained as with 60 and 90 minutes. From an examination of the results of commercial fumigation against the citricola scale (*Coccus citricola*) in 125 groves in Tulare County during the 1917 season, it was learned that there was no practical difference between the killing efficiency of the hydrocyanic acid gas with exposures of 45, 50 and 55 minutes.

Conclusions

It may be concluded from these experiments that an exposure of 45 minutes is sufficient to kill the red scale, under the conditions as given. It is possible that with fumigation carried on at night, where the temperature is lower and the tent leakage possibly less that a longer period may be somewhat more efficient. However, from the data given for the citricola scale, it appears that under normal conditions for commercial fumigation a 45 minute exposure is fully as efficient as a 50 or 55 minute exposure.

President G. P Weldon: Is there anyone who wishes to discuss this paper?

R. S. Woglum: I am in agreement in general with the findings as given in the paper, but in the case of eggs of the purple scale, I found that a longer fumigation period resulted in a better killing.

H. J. Quayle: It should be kept clearly in mind that these experiments were carried on with ordinary fumigation tenting material and during the daytime. Tenting material and atmospheric conditions are two variable factors in relation to the time of exposure.

President G. P. Weldon: The next paper is entitled "A Native Food Plant of *Rhagoletis fausta*," by H. H. P. Severin.

A NATIVE FOOD PLANT OF RHAGOLETIS FAUSTA O. S.[1]

By Henry H. P. Severin, Ph. D., *California Agricultural Experiment Station*

Although the northern or black-bodied cherry fruit fly (*Rhagoletis fausta* O. S.) was described by Osten Sacken (12, p. 346) in 1877, the fact that this trypetid is a serious pest of cultivated cherries was not definitely determined until 1910. As to the native food plants of *Rhagoletis fausta*, Illingworth (11, p. 195) writes as follows:

"From the occurrence of the type material in the alpine regions of the White Mountains the inference would be that the native foods were wild fruits, the most natural food plants being some of the species of wild cherries or plums, or possibly the berries of some of the species of *Berberis* or *Lonicera*."

Cæsar and Spencer (5, p. 7), who have worked with this fruit fly in Ontario, state: "No injury was found on any of our native wild varieties of cherry, but only on the imported ones or on those that had grown up wild from the seeds or roots of these."

In regard to the host plants of the European fruit fly (*Rhagoletis cerasi*) Hagen (9, p. 160) writes: "Loew states that the larva lives in cherries, in *Lonicera xylosteum* and other *Loniceræ*, and in *Berberis vulgaris*, after Frauenfeld. Rosenhauer found it in *Lonicera tartarica*, and this shrub was also present in my garden for thirteen years," but as far as I know, is not infested by a trypetid.

An examination of the wild red, bird, fire or pin cherry (*Prunus pennsylvanica* L.) in Orono, Maine, near the Penobscot River, showed that most of the fruit had been punctured by insects. A few hours observation disclosed the fact that a curculio was puncturing and gnawing holes in the wild cherries to such a depth that the snout was entirely embedded in the flesh. Some of the wild cherries were opened and occasionally a Lepidopterous larva was found, but we did not succeed in breeding the moth. Most of the fruit when opened, however, showed a brown streak in the flesh extending from the skin to the stone.

On July 23, 1914, when the wild cherries were ripe, about a quart of the fruit was gathered from trees and scattered in sterilized sand within jars. During the month of August numerous yellowish puparia were sieved from the sand and were kept in moist, sterilized sand over winter. Under laboratory conditions the adults of *Rhagoletis fausta* issued during the following spring.

In the season of 1915, from July 25 to August 6, ripe wild cherries

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[1] Permission has been granted by Dr. C. D. Woods, Director of the Maine Agricultural Experiment Station, for the publication of this paper.

were again gathered from trees. Puparia were sieved from the sand on August 13–27. This year, however, the puparia were kept in dry sterilized sand but not a single fruit fly emerged during the following spring. No flies issued during the second year and in all probability, the dry sand was unfavorable for the development of the trypetids.

Choke cherries (*Prunus virginiana* L.) were gathered on August 13–18, 1914, but not a single puparium of *Rhagoletis fausta* was obtained from this material.

Several quarts of cultivated cherries were purchased from owners who had a few trees in their dooryards in the residential section of Orono, and one quart was obtained from Hampden, Maine. These ripe sour cherries were placed in breeding jars on July 7–30, 1915. A few plum curculios (*Conotrachelus nenuphar* Herbst.) but no specimens of *Rhagoletis fausta* were reared. No adults of this trypetid emerged in four cages covering thirty-six square feet of soil below three cherry trees in two dooryards. It is not to be inferred, however, from what little work which we carried on, that this fruit fly does not attack cultivated cherries in Maine.

It may be of interest to compare the geographical distribution of the wild cherry (*Prunus pennsylvanica* L.) in Canada and the United States with the present known distribution of *Rhagoletis fausta*.

Sargent (15, p. 522) gives the distribution of *Prunus pennsylvanica* as follows: "Newfoundland to shores of the Hudson's Bay, and westward in British America to the eastern slopes of the coast range of British Columbia in the valley of the Fraser River, and southward through the northern states to Pennsylvania, central Michigan, northern Illinois, central Iowa, and to the high mountains of North Carolina and Tennessee, and on the eastern slopes of the Rocky Mountains of Colorado; common in all the forest regions of the extreme northern states, growing in moist rather rich soil; often occupying to the exclusion of other trees large areas cleared by fire of the original forest-covering; common and attaining its largest size on the western slopes of the Big Smoky Mountains in Tennessee." In regard to the vertical distribution, Rydberg (14, p. 193) states that *Prunus pennsylvanica* occurs at an altitude of 4,000–9,500 feet in Colorado.

According to Cæsar and Spencer (5, pp. 6–7) "British Columbia and Ontario are the only two provinces in Canada" from which *Rhagoletis fausta* has been reported. Chagnon (6, p. 14), however, in his "Preliminary List of Canadian Diptera" records *Rhagoletis fausta* from the vicinity of Montreal, Quebec.

In the United States, *Rhagoletis fausta* has been recorded from the states of New Hampshire and New York. According to Osten Sacken (12, p. 346) the male and female specimens from which the original

description was obtained were taken by G. Dimmock in the alpine region of Mount Washington, New Hampshire. Illingworth (11, pp. 191, 195) records the pest from Ithaca and Trumansburg, New York.

It is evident that the distribution of *Rhagoletis fausta* in Canada and the United States is within the range of *Prunus pennsylvanica.*

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Dr. H. T. Fernald was present and was called upon at this time by President Weldon for a few remarks. Dr. Fernald frankly suggested that he lacked an intimate acquaintance with the problems in the west, and that they were very different from those in the east. He called attention to the fact that considerable work in the west was attracting attention and being applied so far as they were applicable in the east. Dr. Fernald called attention to a Pyralid moth, *Pyrausta nubilalis,* which feeds on hemp and other similar plants, boring in the stems. It came in a shipment of rope about ten years ago and has since taken to the corn, doing as much as 30 per cent damage to the early corn, and even as high as 70 per cent damage to late corn. It has spread over an area of 100 square miles up to the present time.

G. P. Weldon: What is the chance of eradicating it?

H. T. Fernald: Since it occurs in the stems of dahlias and different kinds of grasses, the chances for eradicating it I think are rather remote.

President G. P. Weldon: The Secretary has a few more papers that were sent in by members who were not able to be present, but on account of the hour I am sorry we will have time to read such papers by title only.

The Secretary then read the title and the author's name of the following papers:

* References do not refer to *Rhagoletis fausta.*

APHIS BAKERI AND SOME ALLIED SPECIES

C. P. GILLETTE and L. C. BRAGG

In our aphid studies we have often been puzzled in the placing of several rather closely allied forms that might be grouped around *Aphis bakeri* on account of their resemblance to this species. Probably there are other species that will fall in to this same group, but they are not known to us now.

The species treated in this paper all have short cornicles, in most cases, little, if any, longer than the hind tarsi and cylindrical in form. The cauda is rather short and broad, and in most of the species decidedly short and blunt. The antennæ are shorter than the body with the third joint heavily set with tuberculate sensoria; joint 4 also has sensoria, usually somewhat tuberculate, and joint 5 may or may not have sensoria aside from the permanent one near the distal end. The filament varies to a considerable extent in length in the different species, but never is shorter than joints 5 and 6 taken together in the alate forms.

We have been able to separate the species we have studied by the following key:

KEY FOR ALATE VIVIPAROUS FORMS

Cornicles smooth, not having transverse rows of ridges or chitinous points. . *helichrysi*
Cornicles having many transverse rows of chitinous points.
A. Hind tibiæ with numerous sensoria.
a. Sensoria on distal half of tibia (absent on fall migrants). . . . . . . *viburnicola*
b. Sensoria on proximal half of tibia (also on tibia of apterous viviparous form, but not on males) . . . . *sensoriata* n. sp.
AA. Hind tibiæ without sensoria.
Beak not surpassing hind coxæ . . . . *bakeri*
Beak surpassing hind coxæ . . . . *cratægifoliæ*

APHIS HELICHRYSI Kalt. (Fig. 12, 1–5)

Aphis helichrysi Kalt., Monographie der Pflanzenlause, 1843, p. 102.
Aphis myosotidis Koch., Pflanzenlause, 1857, p. 57.
Aphis helichrysi Koch., Pflanzenlause, 1857, p. 135 (not this species).
Aphis marutae Oest., Aphididæ of Minn., 1887, p. 57.
Brachycaudus helichrysi, V. d. Goot., Zur Systematik der Aphiden, 1913, p. 97.
Brachycaudus helichrysi, V. d. Goot., Kenntnis der Hollandischen Blatt-Lause, 1915, p. 256.

The above list of the more important papers treating of this species, gives the synonymy as we see it. We have *Aphis helichrysi* and *A. myosotidis* from Europe as determined by Van der Goot, and a large collection of what we have been considering to be *marutæ* on a variety of host plants, and we are unable to separate them from one another, so we think they all should fall under *helichrysi* Kalt.

This species feeds chiefly upon composites, but not exclusively. Our records of food plants and dates of capture are as follows:

Place	Date	Collector	Food Plant	Form
Fort Collins	11- 4-07	L. C. Bragg	*Tanacetum balsamita*	alate, apterous
Fort Collins	6-15-09	L. C. Bragg	*Achillea* sp.	apterous
Woods Hole, Mass.	7- 3-09	L. C. Bragg	*Anthemis* sp.	alate
Fort Collins	10-28-10	L. C. Bragg	*Carduus* sp.	apterous
Fort Collins	5-14-11	L. C. Bragg	*Senecio* sp.	alate
Fort Collins	5-16-11	L. C. Bragg	*Urtica*	alate, apterous
Boulder	6-24-11	L. C. Bragg	*Onosmodium* sp.	alate
Fort Collins	9-30-11	L. C. Bragg	*Ambrosia artemisifolia*	apterous
La Porte	9-29-11	L. C. Bragg	*Eupatorium* sp.	alate, apterous
Palo Alto	4-26-12	H. Morrison	*Amsinckia intermedia*	alate
California	1-11-13	W. M. Davidson	*Helianthus*	apterous
Fort Collins	1-27-15	L. C. Bragg	*Cineraria* sp.	alate
Fort Collins	3-29-16	L. C. Bragg	*Bursa bursa*	alate
Fort Collins	6- 1-16	L. C. Bragg	Apple	alate, apterous
Fort Collins	12- 5-17	L. C. Bragg	*Malva* sp.	alate, apterous

Other plants on which this species has been taken in Colorado are Carrot, *Chrysanthemum*, marguerite, *Carum*, heliotrope, *Phacelia* and *Lithospermum*.

The types described by Kaltenbach were taken from *Helichrysum chrysanthemum*, "Balsamite," *Anthemis tinctoria* and *Achillea patarmica* in Europe, all composites. In northern Colorado this species often occurs in special abundance on *Ambrosia artemisifolia*, and *Erigeron canadense*, and, of the cultivated plants, *Tanacetum balsamita* and *Cineraria*.

A peculiar thing in connection with this louse, which is very noticeable where it is abundant upon the plant, is the hard excretion which seems not to be liquid, and which gives a frosted appearance to the foliage upon which it accumulates.

In addition to what is given in the above key, it might be stated that this is the smallest of the group considered, large alate individuals seldom exceeding 1.35 mm.; the antennæ is nearly as long as the body; the cornicles taper slightly in the alate form, and more noticeably in the apterous form, from the base towards the tip. We have found no evidence of either sexual forms or eggs.

APHIS VIBURNICOLA Gillette (Fig. 12, 6–12)

Aphis viburnicola Gill., Entomological News, 1909, p. 280.

This is an abundant species every spring and fall upon the snowball bushes, (*Viburnum*), and to the present, has eluded all attempts to

locate the summer food plant. It seems quite closely allied to the new species, *sensoriata*. The characters shown in figures 6 to 12 of the accompanying plate will serve to separate it readily from any other aphid known to us.

Our records on this species are very numerous. All the young of the stem mother acquire wings and leave the curled leaves for some other food plant. The sexupara begin to return early in September, the males coming a little later, when the earliest born oviparous females are about half grown.

APHIS SENSORIATA, new species (Fig. 12, 13–26)

Described from alcoholic material taken by L. C. Bragg at Log Cabin, Colorado, July 27, 1917, altitude 8,000 feet, and by C. P. Gillette, at Fort Lewis, Colorado, October 1, 1917, altitude 8,800 feet. In both cases the lice were infesting the leaves of *Amelanchier* sp. The July specimens are all apterous viviparous, and the October specimens include alate sexupara, alate males and oviparous females.

APTEROUS VIVIPAROUS FEMALE, Summer Form. The specific name is suggested by the presence of sensoria upon the hind tibiæ of adult alate and apterous virgogenia, the young apterous virgogenia and the oviparous females, and the irregularity of the occurrence of sensoria on the antennæ, especially of the apterous virgogenia, where the number varies from zero to 18 on the third segment among the 10 apparent adults we have.

General color some shade of green with transverse black or blackish markings upon the segments of the abdomen above, and a large blotch covering most of the dorsum of segments 4, 5, and 6, at least. In life, the color is black or blackish throughout, with cornicles pale greenish yellow to blackish in the older examples; antennæ, legs, cornicles and cauda black or dusky; beak attaining or even surpassing hind coxæ; cornicles short (.15 mm.), and gradually tapering from base to tip; cauda short and broadly oval at tip, not longer than width at base; length of body, 2 to 2.25 mm.; width, 1.30 to 1.50 mm.; length of antenna, 1 to 1.10 mm.; joints of antenna in the following proportions: I, 10; II, 8; III, 32; IV, 22; V, 22; VI, 10; spur, 27; joint III having from 0 to 18 oval or circular sensoria. In all but one example, the sensoria on joint III vary from 0 to 2, and on joint IV from 0 to 6. Hind tibia .80 mm. in length with numerous, small oval sensoria on the swollen basal half. Small apterous lice, down to 1.25 mm. in length, all have the hind tibiæ swollen and with sensoria, but with a smaller number than the adult. Figure 19, of Plate I shows the tibia of a nymph that does not appear to be beyond the second moult. See figures 13 to 19.

ALATE VIVIPAROUS FEMALE, Summer Form. Described from examples taken at Log Cabin, Colorado, July 26, 1917, and at Fort Lewis, October 1, 1917.

General color, black or blackish throughout; basal portions of femora and tibiæ brown; antennæ, cornicles and cauda black; cornicles slightly tapering towards the tip and as long as hind tarsi; cauda blunt and not longer than width at base; antennæ 1.20 mm. long, nearly attaining base of cornicles; joints of antennæ in the following proportions: I, 7; II, 7; III, 42; IV, 26; V, 23; VI, 11; spur,

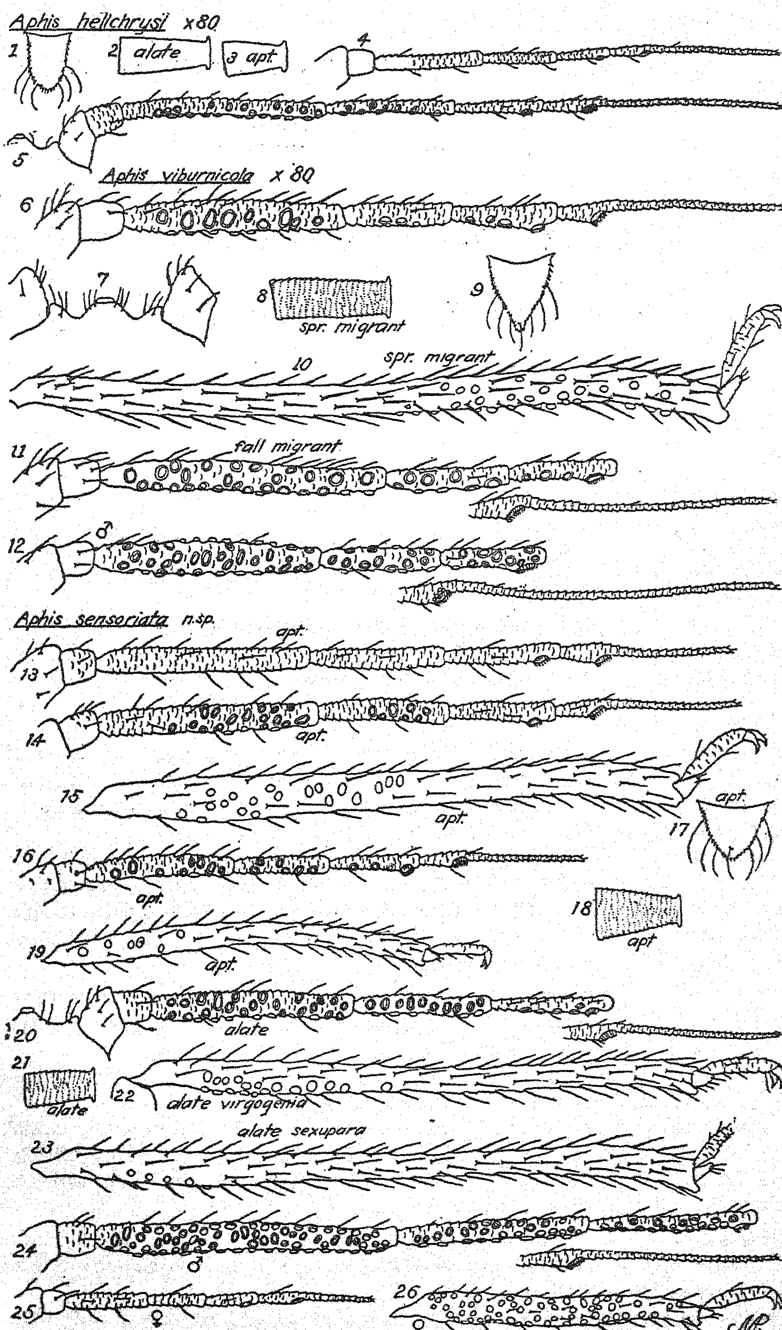
Aphis helichrysi x80
1
2 alate
3 apt.
4
5
Aphis viburnicola x 80
6
7
8
spr. migrant
9
10
spr. migrant
11
fall migrant
12
♂
Aphis sensoriata n.sp.
13
apt.
14
apt.
15
apt.
16
apt.
17
apt.
18
apt
19
apt.
20
alate
21
alate
22
alate virgogenia
23
alate sexupara
24
♂
25
♀
26
♀

FIG. 12

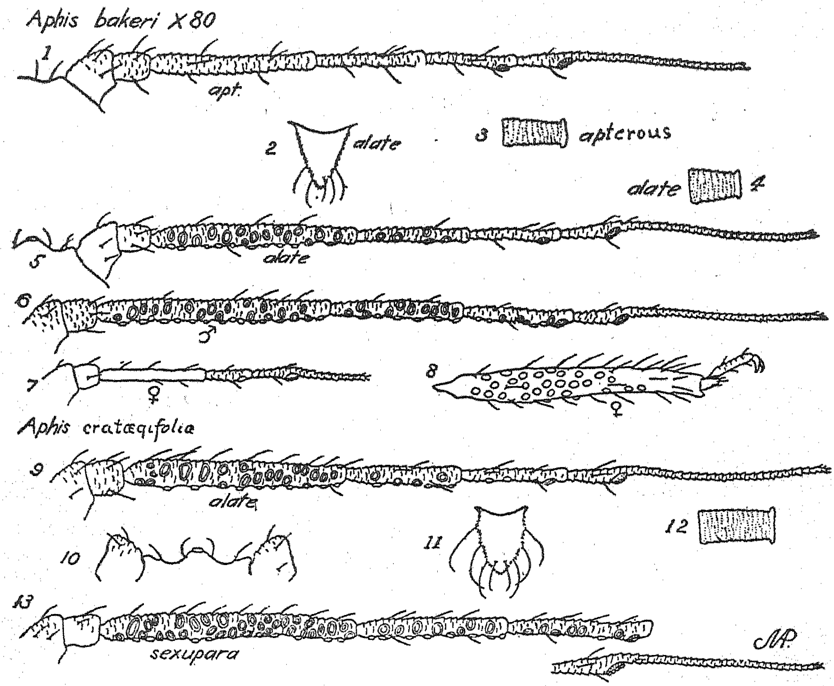

FIG. 13

31; sensoria somewhat tuberculate, joint III with about 36, joint IV with about 12, and joint V with about 6 oval or circular sensoria; length of fore wing, 2.75 mm.; venation normal; hind tibia, 9 mm. long, swollen in proximal third and with about 15 to 20 oval or circular sensoria. See figures 20–23.

ALATE SEXUPARA OR FALL MIGRANT. The fall migrants, so far as can be determined from our alcoholic material, differ from the spring migrants by having a few more sensoria on joints 3 and 4 of the antenna and much fewer sensoria on the hind tibia, about 5 to 10 in the examples studied. Examples taken October 1, 1917, on *Amelanchier* leaves at Fort Lewis, Colorado.

Fig. 12. *Aphis helichrysi.* 1, cauda; 3, cornicle; 4, antenna of apterous virgogenia; 2, cornicle; 5, antenna of alate virgogenia.

Aphis viburnicola. 6, antenna; 7, vertex; 8, cornicle; 9, cauda; 10, hind tibia of spring migrant; 11, antenna of fall migrant; 12, antenna of male.

Aphis sensoriata. 13, 14 and 16, antennæ; 15, hind tibia; 17, cauda; 18, cornicle of adult apterous virgogenia; 19, tibia of nymph; 20, antennæ; 21, cornicle; 22, hind tibia of alate virgogenia; 23, hind tibia of alate sexupara; 24, antenna of male; 25, antenna; 26, hind tibia of oviparous female.

Fig. 13. *Aphis bakeri.* 1, antenna; 3, cornicle of apterous virgogenia; 2, cauda; 4, cornicle; 5, antenna of alate virgogenia; 6, antenna of male; 7, antenna; 8, hind tibia of oviparous female.

Aphis cratægifoliæ. 9, antenna; 10, vertex; 11, cauda; 12, cornicle of alate virgogenia; 13, antenna of sexupara.

All figures enlarged 80 diameters. Original, Miriam A. Palmer, *Delineator.*

ALATE MALES. Examples taken along with the sexupara described above. Color of abdomen apparently lighter than in the alate viviparous forms; length, 1.40 mm.; antenna (figure 24) as long as the body, filament about as long as joints V and VI combined; sensoria on joint III, about 50; joint IV, about 35; joint V, about 25; and joint VI with permanent sensoria only; cornicles shorter than hind tarsi; hind tibiæ 70 mm. in length, not swollen at base and entirely without sensoria. The male is very readily separated from the other alate forms, but the spring and fall migrants resemble one another rather closely.

OVIPAROUS FEMALE. What appear to be mature apterous egg-layers in alcohol may be described as follows: color almost uniform pale yellow throughout, length 1.25; antennæ .58; and hind tibia .52 mm.; antenna with permanent sensoria only; hind tibia swollen and set with abundant sensoria throughout its entire length; cauda very broadly rounded posteriorly and broader than long. Examples taken along with the sexupara and males described above from *Amelanchier*. See figures 25 and 26.

This is an interesting species from a morphological standpoint, and it is very closely allied to *viburnicola*.

APHIS BAKERI Cowen (Fig. 13, 1–8)

Aphis bakeri Cowen, Hemiptera of Colorado, Bull. 31, Colorado Experiment Station, p. 118, 1895.
Aphis cephalicola Cowen, Hemiptera of Colorado, Bull. 31, Colorado Experiment Station, p. 118, 1895.
Aphis bakeri, Gillette, Journal of Economic Entomology, 1910, p. 405.
Aphis bakeri, Gillette and Taylor, Bull. 133, Colorado Experiment Station, p. 28, 1908.

We find this species living throughout the year on clover and giving migrants to apple and *Cratægus* in the fall. On occasional years it becomes quite injurious to red clover. This was specially true in northeastern Colorado and parts of Idaho and Utah in 1916, crops being almost ruined in some cases.

APHIS CRATAEGIFOLIAE Fitch (Fig. 13, 9–13)

Aphis cratægifoliæ Fitch, Cat. Hom. N. Y. St. Cab., p. 66, 1851.
Aphis cratægifoli Thomas, 8th Rep., Insects of Illinois, p. 101, 1879.
Aphis cratægifoliæ Oestlund, Aphididæ of Minn., p. 51, 1887.
Aphis brevis, Sanderson, 13th Annual Rep., Del. Exp. Sta., p. 157, 1902.
Aphis brevis, Patch, Jour. Agr. Res., vol. III, p. 431, 1915.
Aphis cratægifoliæ, Quaintance and Baker, Farmers' Bull. 804, p. 18, 1917.

We have not taken this species in Colorado, but have specimens from other states as follows:

Knoxville, Illinois, September 12, 1907, from Red Haw, J. J. Davis.
Orono, Maine, June 14, 1912, from *Cratægus*, Edith M. Patch.
Winthrop, Maine, October 8, 1913, from *Cratægus*, A. C. Baker.

Aphis bakeri occurs freely upon *Cratægus* in Colorado, but is distinguished by its short beak.

BIOLOGICAL NOTES ON SOME FLATHEADED WOODBORERS OF THE GENUS BUPRESTIS

By H. E. Burke, *Specialist in Forest Entomology, Branch of Forest Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture*

According to Henshaw's "List of the Coleoptera of America, North of Mexico" there are about twenty-one species of Buprestis in the United States. During the past fifteen years various members of the Branch of Forest Insect Investigations have collected and made numerous biological notes on seventeen of the species. The following paper is a brief summary of these notes.

All of the species are woodborers and so far as known are able to lay their eggs directly in the crevices of the wood as the young larvæ can thrive without any bark food. This is not always done, however, and eggs are often placed under or in crevices of the bark where the larvæ can get to the wood easily.

The observations made indicate that at least two years are passed in the larval stage and in many cases from that on up to fifteen or twenty years. Probably some larvæ from almost every group of eggs have retarded development and emerge as beetles from one to several years after the main brood.

The larval characters and biologies indicate that the genus should be divided into three groups quite similar to those determined upon by Casey in his "Studies in the American Buprestidæ" which were made from a study of the adult characters alone. The larvæ of the first group, Buprestis proper; rufipes, læviventris, confluens, etc., have a small rugose hood around the apex of the V shaped marking on the dorsal plate of the first segment and very slight rugose markings along the groove on the ventral plate. In this group pupation takes place in the spring and the beetles emerge soon afterwards. In group two, subgenus Cypriacus of Casey, aurulenta, etc., the rugose hood around the apex of the V is much larger and the rugose area along the ventral marking is broad. Pupation in this group takes place during the summer and the beetles remain in the pupal cells until the following spring. In group three, subgenus Stereosa of Casey, apricans, etc., there is no distinct rugose hood around the apex of the V but almost the entire dorsal plate is rugose as is also the ventral plate. Pupation takes place in the summer and the beetles winter over in the pupal cells as with group two.

The species of group one taken as a whole mine more in dead dry wood and seldom cause serious injury. Often they are quite bene-

ficial because they mine stumps on cutover land and thus cause rapid decay and easy clearing. The species of groups two and three often attack slightly injured trees and cause severe damage to the wood. One millman working in longleaf pine timber in the South, some of which had been boxed for turpentine, estimated his loss from the mines of Buprestis apricans as 1 per cent totally destroyed and 5 per cent reduced to the lower grades.

Such brilliantly colored species as aurulenta, adjecta, etc., may have a possible value as ornaments. Very beautiful and unique stickpins and breast pins can be made by mounting the beetles in a gold frame.

Responsibility for the identifications of the species discussed in this paper rests with the writer. Most of the beetles have been determined at various times after consultation with Dr. E. A. Schwarz of the United States National Museum, Mr. W. S. Fisher of the Branch of Forest Insect Investigations and Dr. E. C. Van Dyke of the University of California. There is a great deal of confusion in regard to the identity of some of the species and the genus needs a careful revision by a good taxonomist who will use all of the biological data obtainable to supplement the taxonomic characters.

Buprestis rufipes Oliv.—Maryland, District of Columbia, West Virginia, Virginia and Georgia; mines dead wood of scars and limbs of live trees and wood of dead trees; hickory (Hicoria sp.), beech (Fagus atropunicea), chestnut (Castanea dentata), white oak (Quercus alba), live oak (Q. virginiana) and tulip tree (Liriodendron tulipifera); does some damage to the wood of standing dead trees and, according to Mr. T. E. Snyder, to chestnut telephone and telegraph poles; larvæ common in the District of Columbia but beetles rarely taken by collectors.

Buprestis gibbsii Lec.—Southern Oregon, sierran California; on black cottonwood (Populus trichocarpa) and black oak (Quercus californica); flies in July and August; rare; has not been reared; varies a great deal in the amount of yellow and red on the elytra.

Buprestis confluens Say.—Colorado, Utah and sierran California; mines wood of injured, dying and dead trees; aspen (Populus tremuloides) and common cottonwood (P. deltoides); flies from July to September; larvæ and work very common in the Lake Tahoe region of California but beetles rather rare; lives in the wood several years as a larva; pupates in the spring.

Buprestis lineata Fab.—Maryland, District of Columbia, Virginia, North Carolina, Georgia and Texas; mines wood of injured, dying and dead trees; loblolly pine (Pinus tæda) scrub pine (P. virginiana), and longleaf pine (P. palustris); pupates and transforms to beetle stage

from April to June; flies from April to August; causes some damage to the wood of injured and dead trees but is a benefit in clearing land because it mines the wood of stumps and causes more rapid decay. At Tryon, N. C., on July 23, 1903, Mr. W. F. Fiske found a number of very small adults of what appears to be this species on the limbs of a felled dead hickory.

Buprestis consularis Gory.—Black Hills of South Dakota, Colorado and Idaho; on dying and dead yellow pine (Pinus ponderosa scopulorum) and douglas spruce (Pseudotsuga taxifolia), especially trees attacked by Scolytids; flies in July, August and September.

Buprestis connexa Horn.—Idaho, northern and sierran California; on stumps and felled trees of western yellow pine (Pinus ponderosa) and jeffrey pine (P. jeffreyi); flies from July to September.

Buprestis nuttalli Kirby.—Colorado; one specimen of what appears to be this species collected with B. consularis on bark of dead yellow pine (Pinus ponderosa scopulorum), by Mr. Geo. Hofer on August 2, 1916, in Waldo Canyon.

Buprestis læviventris Lec.—Idaho, Arizona, Oregon and California; mines wood of injured, dying and dead trees; sugar pine (Pinus lambertiana), yellow pine (P. ponderosa), lodgepole pine (P. murrayana), digger pine (P. sabiniana) and Monterey pine (P. radiata); pupates and transforms to beetle stage from March to July; flies from May to October; causes some damage to the wood of injured and dead trees; causes rapid decay in yellow pine stumps and thus assists in the clearing of land; probably occurs throughout the range of its primary host the yellow pine and may be the same as nuttalli; one immature specimen which appears to be this species was taken from the douglas spruce (Pseudotsuga taxifolia).

Buprestis maculiventris Say.—Black Hills of South Dakota, Colorado, New Mexico and Arizona; flies from July to September in forests of yellow pine (Pinus ponderosa scopulorum). One specimen which appears to be this species was taken by Mr. E. J. Kraus at Pike, N. H., on July 8, 1908.

Buprestis subornata Lec.—California; mines wood of dead yellow pine (Pinus ponderosa); flies from July to October; adults rather rare, found most commonly on the foliage of young trees.

Buprestis rusticorum Kirby.—Montana, Colorado, Idaho, Utah, Arizona, Washington, Oregon and California; mines wood of dying and dead trees; douglas spruce (Pseudotsuga taxifolia), alpine fir (Abies lasiocarpa), lowland fir (A. grandis), and white fir (A. concolor); pupates and transforms to the beetle stage from April to July; flies from May to October; does some damage to the wood of dying and dead trees; probably occurs throughout the Rocky Mountain and

Pacific regions wherever its primary hosts, the true firs, occur; on August 11, 1915, Mr. F. B. Herbert found a male læviventris mating with a female rusticorum but in the rearing of many specimens we have always obtained læviventris from the pines and rusticorum from the true firs and douglas spruce except in the one indefinite instance mentioned under læviventris.

Buprestis langii Mann.—South Dakota, Colorado, Montana, Utah, Washington, Oregon and California; flies from June to September; numerous specimens have been taken on alder and willow leaves and some specimens on the bark of pine trees and spruce trees but none have been reared from the wood.

Buprestis striata Fab.—Thomasville, Georgia; one specimen taken on March 20, 1905, by Mr. W. F. Fiske on bark of longleaf pine (Pinus palustris).

Buprestis aurulenta Linn. (lauta Lec.).—Montana, Colorado, Idaho, Arizona, Washington, Oregon and California; mines wood of injured, dying and dead trees; western white pine (Pinus monticola), sugar pine (P. lambertiana), yellow pine (P. ponderosa) and (P. ponderosa scopulorum), jeffrey pine (P. jeffreyi), lodgepole pine (P. murrayana), digger pine (P. sabiniana), monterey pine (P. radiata), blue spruce (Picea parryana), sitka spruce (P. sitchensis) and douglas spruce (Pseudotsuga taxifolia); pupates and transforms to beetle during the summer and early fall; winters over as a beetle in the pupal cell in wood; emerges following spring and summer; flies from April to September; causes considerable damage to the wood of lightning struck, fire scorched, blazed and otherwise injured trees by mining the pitchy scars; may live for years as a larva in the wood; seems to occur throughout the range of its primary host, the douglas spruce.

Buprestis villosa Lec.—California; appears to have been named from a woolly specimen of aurulenta. Such specimens occur quite frequently among typical aurulenta.

Buprestis adjecta Lec.—Washington, Oregon, California; mines wood of yellow pine (Pinus ponderosa); flies from July to September; adults common in the Lake Tahoe region of California but the work appears to be scarce.

Buprestis apricans Hbst.—Virginia, North Carolina, South Carolina, Georgia, Florida and Texas; mines wood of injured, dying and dead trees; loblolly pine (Pinus tæda) and longleaf pine (P. palustris); pupates and transforms to the beetle in the summer and fall; winters over as a beetle in the pupal cell in the wood and emerges in the early spring; lives for several years as a larva in the wood; flies from February to May and probably all summer; causes considerable damage to the wood of blazed, fire scorched and otherwise injured trees especially

to those boxed in turpentine operations. The riddling of the trunk by the worm holes spoils the use of the wood for lumber and often shortens the turpentine crop because the weakened trunk can not support the crown during the heavy winds and is broken off. Dr. A. D. Hopkins was the first to discover and record the habits of this species which he listed as the turpentine borer in bulletin 48 of the Division of Entomology.

THE EUROPEAN EARWIG, FORFICULA AURICULARIA LINN.

By E. O. Essig, *University of California, Berkeley, Calif.*

The European earwig has been known for several years in the eastern part of the United States[1] and it may be of interest to know that it also occurs in the northwestern part, having been received in considerable numbers from Seattle, Washington, September 16, 1916. The specimens were sent by express and confined alive in a jelly glass packed in a small wooden box so that the top of the glass, which was held in place by ordinary wrapping twine and punched full of holes so that the insects would not smother in transit, was exposed. The specimens, some fifty in number and representing both sexes, arrived in Berkeley in splendid condition, not a single one being dead, and is a fine example of how insects may become accidentally established in new territory. Packed as the glass was it is remarkable that it came through without being broken and we may be thankful that the colony was not thus turned loose to repeat, in California, what it is doing in other places.

At Seattle it is reported as being abundant in houses and very destructive to roses in the garden.

In Denmark it has proved destructive to Cauliflower.[2]

Knowing that it is so close to our state we should all be on the alert to prevent its entrance and to caution collectors and the general public regarding the menace.

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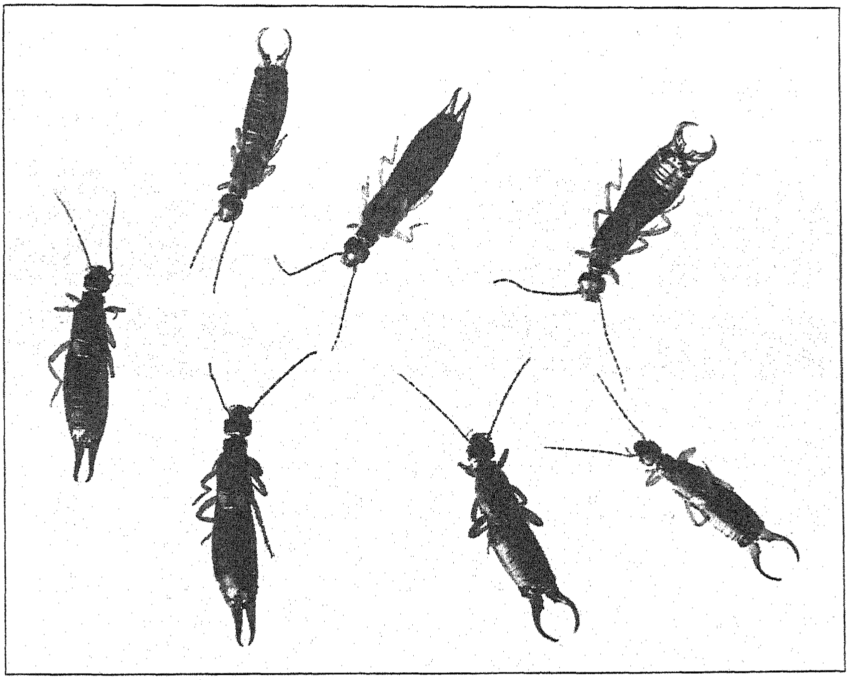
[1] Hebard, M., Ent. News, xxviii, p. 323, July, 1917—Bibliography and notes.

[2] Lind, J., Rostrup, S., and Kolpin-Ravn, F., 79 Bertning fra Statens Forsogs virks. i Plantekultur, Copenhagen, no. 30, 1914. (Review Appld. Ent. Ser. A. III, p. 247, 1915.)



The European earwig, *Forficula auricularia* Linn. x 3. (Original)

STORAGE OF MANURE AND FLY SUPPRESSION AT DURBAN REMOUNT DEPOT

By Charles K. Brain, M. Sc.,
Division of Entomology, Pretoria, South Africa

During a recent visit to Durban, Natal, I had the pleasure of visiting the Transport and Remount Mobilization Depôt which was established in November, 1915, in connection, chiefly, with the military operations in German East Africa. I am informed that during its existence approximately 100,000 animals, mostly horses, mules and donkeys, have passed through this depôt, and the average number maintained during most of the time has been about 3,300 with a maximum at any one time of 10,000. The chief interest, entomologically, lies in the fact that although this depôt was situated on reclaimed swamp within fifteen minutes' walk from the centre of the town, it has not caused the slightest inconvenience to the inhabitants and there has been an entire absence of smell and house-fly nuisance.

This is entirely due to the energy and common-sense methods of the O. C., Major W. F. Averre, and since some of the control measures are not identical with those generally recommended, I give the details as evolved as the work proceeded.

It may be remarked that the climatic conditions of Durban are admirably suited to the rapid multiplication of house-flies, and the question of successfully storing large deposits of stable manure in close proximity to towns and camps has always been a difficult one but one of particular importance at such a time as the present. The Remount Depôt in question is located at Lord's Grounds, the Agricultural Show Grounds of Durban, a town of some 70,000 inhabitants; as this site was not sufficiently large (25 acres), surrounding ground was taken in until an area of approximately 60 acres was involved. The show ground itself is low-lying, mainly composed of reclaimed swamp, and within half a mile of the coast. An additional 10 acres, which had been levelled and drained for use as a sports' ground, were first added and later some 25 acres of undeveloped and undrained vlei land with occasional sand-dunes completed the extent of 60 acres. Over this whole area drains and roads were constructed, the latter top-dressed with cinders, and paddocks were enclosed. The buildings already existing on the show ground were utilized for housing the staff, which numbered some seven hundred when in full force. The means employed for fly control consisted of constant attention to the collection of dung, none being allowed to remain for twenty-four hours, the systematic storage and

packing of manure, and continuous spraying with poison bait and contact insecticide.

Every day the manure and litter from stalls and paddocks was swept up and carted to huge trenches previously prepared in the sand-dunes. These trenches were dug to a depth of about ten feet, *i. e.*, down to the clay layer sublying the sand. They were often twenty feet wide and fifty to seventy long. The carting was done by a special staff of sixteen natives under a non-commissioned officer. The average amount was approximately 150 to 160 scotch-cart loads per day. This was spread out in the huge trench until a depth of about one foot was reached when other boys proceeded to cover it with a thin layer ($\frac{3}{4}$ inches) of sand, ashes or earth. It was arranged that, in carting fresh material, it was necessary to pass and re-pass over the manure already spread so that it became well pressed down and, as new layers were added, each day's deposit received its coat of sand and afterwards its rolling or ramming down. When a trench was filled it was covered with a layer of a foot or so of earth or sand and then thoroughly rolled for two or three days. Disinfectants or lime were not added. This method of storing produces a dense peaty mass of manure which analysis shows to be of particularly good quality. One large deposit of the manure was purchased recently by an Association and a small trolley-line laid down for its removal to the railway siding.

For sweeping manure from the stalls, hard brushes are used; and, although the work is thoroughly done, there is always a number of flies around. To deal with these four natives under a "conductor" are constantly treating them with a contact spray. The mixture used consists of:

Caustic soda	2 pounds	
Boiling water	50 gallons	
Paraffin	5 gallons	added while hot
Hycol	5 gallons	

An attempt is made with this to actually hit the settled flies and it was found that a broad-bore garden syringe was more effective than an ordinary spray pump.

Fly bait consisting of:

Arsenite of soda	5 pounds[1]
Black sugar	5 to 20 pounds
Boiled in water	25 gallons

is distributed on blue-gum branches and pieces of sacking. These are

[1] This seems excessively high in arsenite, being twice the amount usually recommended. It has been reported by some workers that if too much arsenite be used it acts as a repellent, defeating the purpose of a bait. C. K. B.

placed in all latrines, dormitories, cook-houses and stores and are constantly renewed.

That the measures adopted have proved effective is well illustrated by the fact that on several occasions the Oval of the show grounds has been used for patriotic functions attracting thousands of the public, and yet on no occasion has the least inconvenience been caused by the close proximity of the large number of animals in the Depôt, nor by the thousands of tons of stored manure.

Scientific Notes

A Promising New Contact Insecticide. From the results of a series of experiments, it has been determined that the most efficient contact insecticides must be of an oily or soapy nature. Based upon these observations, a new contact insecticide has been made by the formation of a soap or soap-like salt by the union of nicotine and oleic acid. This chemical is nicotine oleate. It dissolves in soft water forming a soapy solution which may be used to emulsify an animal, vegetable or mineral oil.

The following experiments give an idea of its value. First, Nicofume, containing 40 per cent of nicotine diluted with water to give a nicotine content of 1 part in 1,000 of water, killed 95 per cent of the chrysanthemum aphis. Nicotine oleate, diluted to give 1 part of nicotine in 1,500 parts of water, killed 96 per cent, while diluted to 1 part of nicotine in 4,500 parts of water killed 63 per cent.

Second, Nicofume, diluted to a nicotine content of 1 part in 1,500 with 2 parts of laundry soap added, killed 93 per cent of the chrysanthemum aphis, while the nicotine oleate with a nicotine content of 1 to 2,250 killed 97 per cent.

Third, Nicofume in aqueous solution does not kill mealy-bugs. Nicotine oleate used at the rate of 1 to 500 will kill a few mealy-bugs and a few egg clusters. Two per cent of a vegetable, animal or mineral oil emulsified in the nicotine oleate solution will kill mealy-bugs and their eggs. An emulsion containing 1 part of nicotine in 500 parts of water with 2 per cent kerosene killed 79 per cent of the adult mealy-bugs and their older larvæ, 98 per cent of the eggs, and 98 per cent of the young larvæ.

Fourth, Preliminary experiments have shown that about 85 to 90 per cent of the soft scale on greenhouse plants may be killed using nicotine oleate at a dilution of 1 part of nicotine to 500 parts of water.

Fifth, Preliminary experiments have shown that adults and larvæ of the white fly may be killed at the same dilution as used for the soft scale.

All experiments mentioned were conducted under laboratory conditions, care being taken to hit all the insects used in the experiments. Under field conditions it may be necessary to use a higher percentage. Nicotine oleate being nonvolatile it is more necessary to insure striking all insects than in the use of a volatile compound like nicofume.

Nicotine oleate may be made directly from any nicotine preparation containing free nicotine. Two and one-half parts of a 40 per cent nicotine solution unites with $1\frac{3}{4}$ parts of commercial oleic acid or red oil. Four and one-fourth parts of this soap will then contain 1 part of nicotine or will equal $2\frac{1}{2}$ parts of the 40 per cent nicotine solution. Two and one-half quarts of 40 per cent nicotine solution costing about $7.00 can be mixed with $1\frac{3}{4}$ quarts of commercial oleic acid costing about 90c. making $1\frac{1}{4}$ gallons of nicotine oleate. For spraying to control plant lice, where a gallon of a

40 per cent nicotine solution costing about $11.00 would be used to make 500 gallons of spray, 1 gallon of nicotine oleate costing about $6.50 would make 650 gallons of a spray solution as effective if not more effective than the spray containing free nicotine. The nicotine oleate will cost the farmer about $1.00 a hundred gallons where the free nicotine spray will cost $2.20 per hundred gallons.

To make the oil emulsion spray with nicotine oleate 10 parts of kerosene is mixed with $1\frac{1}{4}$ parts of commercial oleic acid and then $2\frac{1}{2}$ parts of 40 per cent nicotine solution is added and thoroughly shaken. Ten parts of water is then added and again thoroughly shaken. For use against mealy-bugs, white fly and soft scale this quantity is then mixed with 480 parts of soft water.

In sprays where nicotine oleate is used the spray water must be soft (rain or distilled water). To make nicotine oleate only those tobacco extracts containing free nicotine can be used. The stearate or palmitate of nicotine may be made in the same way, but is not as effective a spray as the oleate. Nicotine oleate is not volatile, hence should not be used on plants to be eaten, such as lettuce. The effect on plants has not been completely studied although sprays containing nicotine oleate equal to 1 part of nicotine in 100 of water did not injure tomatoes or coleus. Slight injury was noted on tender leaves of greenhouse roses when sprayed at the above strength.

On dormant trees the use of a rather nonvolatile oil such as linseed, cottonseed, or fish oil emulsified with nicotine oleate should be valuable for the destruction of insect eggs or scale insects.

A PATENT HAS BEEN APPLIED FOR THIS COMPOUND AND WHEN OBTAINED WILL BE GIVEN TO THE PUBLIC SO THAT ANYONE WILL BE ABLE TO MANUFACTURE IT.

William Moore

Notes From El Centro (California) Field Station. Not a trace of *Hippodamia convergens* has been seen in or around Imperial Valley since the advent of midwinter conditions, although the winter has been a very mild one thus far. Search in plant lice infested grain fields, basal volunteer shoots of cotton, along the banks of the Alamo and New Rivers, and at altitudes from 1,000 feet to 4,000 feet in the Laguna Mountains, west of the Valley, has failed to reveal any indications of hibernating ladybirds.

An inspection of grain fields in scattered parts of the Imperial Valley, made January 31, showed that all fields over a week old were quite generally infested with *Aphis avenæ.* The average infestation, as based on counts of 160 stools, was computed at that time to be 69.4 per cent. The colonies, which consisted of wingless females, their young, occasional nymphs, and rarely a winged migrant, appeared of rather recent establishment. Although parasites and syrphid larvæ were seen, no *Hippodamia* individuals were present.

The cotton aphis (*Aphis gossypii*) is quite commonly seen on *Malva* leaves, to which related plants they have probably migrated upon the recent frosting of the cotton foliage.

E. A. McGregor

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1918

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS.

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The appearance of number 11 of the Emergency Entomological Service, United States Department of Agriculture, reporting coöperation between Federal, State and Station Entomologists and other agencies, marks the beginning of a second season under war conditions. A timely summary such as this is invaluable to every economic entomologist, covering, as it does, all fields of activity and giving early and reliable information regarding developments in adjacent states, as well as in more remote parts of the country, and it is to be hoped that this service may become a permanent feature. Information is of value largely in proportion to its timeliness and all too many reports and bulletins appear long after the insects they discuss have ceased, for the time being, pernicious activity. This emergency service—it should be designated seasonable service—remedies this difficulty in large measure and it may well be supplemented and extended by a somewhat modified local service in the various states, coöperating particularly with county agricultural agents and others in position to disseminate information and secure the effective adoption of preventive or control measures. The Liberty Loan and Red Cross have set high standards in coöperation. It is all for the same cause. Can entomologists secure, in their own lines, relatively as good results?

Current Notes

Conducted by the Associate Editor

Mr. Albert Hartzell has been appointed assistant in entomology at the Iowa College and Station.

Prof. E. H. Dusham has been promoted to be Professor of Entomology at the Pennsylvania State College.

S. W. Frost, Cornell University, has been appointed entomologist of the Adams County, Penn., laboratory to study fruit insects.

Prof. John H. Comstock of Cornell University was recently elected a correspondent of the Academy of Natural Sciences of Philadelphia.

Mr. R. R. Reppert, graduate assistant of the Kansas State Agricultural College, has accepted a position as Assistant Entomologist of Virginia.

Dr. E. F. Phillips, Bureau of Entomology, attended the meeting of the National Beekeepers' Association at Burlington, Iowa, February 19–20.

Prof. Herbert Osborn of the Ohio State University, has been appointed an associate on the staff of the Ohio Agricultural Experiment Station.

Mr. T. H. Parks, extension entomologist of the Kansas State Agricultural College, resigned April 15 to accept a similar position with Ohio State University.

Mr. W. E. Jackson became assistant entomologist of the Texas Station, October 1, 1917, and has taken up work in combating foul brood diseases of the apiary.

Dr. J. H. Merrill, assistant professor of Entomology, Kansas State Agricultural College, has been appointed State Apiarist of Kansas. He still retains his position with the College.

Mr. M. D. Leonard of Cornell University has been appointed entomologist at Girard, Erie County, laboratory of the Pennsylvania State College, and will study vegetable insects.

The Agricultural Appropriation bill now in conference carries an item of $500,000.00 for the pink bollworm work in Texas and Mexico, including the border inspection service.

Mr. P. W. Mason, assistant professor of Entomology at Purdue University, Lafayette, Ind., has resigned to accept a position in the Bureau of Entomology of the U. S. Department of Agriculture.

Messrs. R. W. Gies and J. B. Leslie, Chief Inspectors respectively of the Union and Bergen County, New Jersey, Mosquito Extermination Commissions, have received commissions in the Sanitary Corps of the national army.

Mr. E. O. G. Kelly, for many years in charge of the Wellington (Kansas) Station of the Federal Bureau of Entomology, has accepted a position as Extension Entomologist with the Kansas State Agricultural College.

According to *Science*, Prof. James Zetek, professor of biology and hygiene at the Instituto Nacional de Panama, has been appointed entomologist of the Board of Health Laboratory of the Ancon Hospital, Canal Zone.

Mr. George S. Demuth, Bureau of Entomology, left Washington February 20 for a six weeks' trip in California where a series of meetings on the control of bee diseases were held in coöperation with E. F. Atwater of the Bureau.

According to *Nature* the Entomological Society of Spain has recently been founded, with its center for the present at St. Saviour's College, Saragossa. Dr. Hermenegildo Gorria of Barcelona is president and the Rev. R. P. Longinos, Navas, S. J., Secretary for 1918.

Mr. C. H. Hadley, extension entomologist, Pennsylvania State College, has been placed in charge of entomological research, and for the present is to be located at Bustleton, Philadelphia County laboratories, as entomologist and will give attention to truck crop insects.

Prof. C. W. Woodworth of the University of California is spending his sabbatical year in Nanking, China, in helping to develop the Agricultural College of the University of Nanking, along entomological lines. Entomological literature is needed by the University Library.

A hearing was called at 10 o'clock a. m. for May 28, by the Federal Horticultural Board at Washington, D. C., to receive testimony regarding the advisability of restricting or prohibiting the importation of nursery plants into the United States from foreign countries.

Prof. William A. Riley goes to Minnesota as Professor of Entomology and head of the Division of Entomology and Economic Zoölogy and not, as has been stated earlier, as Professor of Parasitology. He plans to continue teaching along lines he developed at Cornell University.

The following resignations in the Bureau of Entomology are announced: P. W. Erbaugh, bee culture, to enlist in the Marine Corps; David Running, extension work in bee culture, New York; J. H. Wagner, bee culture; H. B. Parks, cereal and forage insects, to enter the Texas state extension service; E. Phillip Barrios, to take up county agent work in Louisiana; Roswell C. Pickett, extension work, truck crop insects, Texas.

W. Dwight Pierce, with the approval of Dr. L. O. Howard, is conducting a class in the entomology of disease, hygiene and sanitation, with special reference to army needs and the possibility of there being a call for a large number of men prepared for service along these lines. There is a weekly lecture in Dr. Hunter's room and this is supplemented by reports upon special topics from various members of the class. The proceedings are mimeographed and distributed to the class and others interested even if they are not able to attend the lectures. Over one hundred copies of the proceedings are now distributed.

Mr. P. van der Goot, of Buitenzorg, Java, Entomological assistant at the great sugar experiment station there, was in Washington from the 15th to the 25th of February, looking up matters connected with the injurious insects of tropical crops. Mr. van der Goot is especially well known by his writings, his large contribution to the knowledge of Aphididæ of Java and other papers of importance. He speaks English very fluently, and is still a young man with many years of work ahead of him. He is on his return to Java from Holland, and in crossing this country will stop at New Orleans, Tucson and Pasadena, and hopes to spend ten days in Hawaii.

The following transfers have been made in the Bureau of Entomology: R. H. Hutchinson, assigned to work on human lice, New Orleans, La.; A. C. Johnson to Dallas, Tex., for three months; F. S. Chamberlain, to take charge of tobacco bud worm work, Quincy, Fla.; F. R. Cole, truck crop insects, to cereal and forage insects, Forest Grove, Ore.; Robert Larrimore, special field agent, extension service, to research service, truck crop insects; F. B. Milliken, stored insect investigations to extension service, lower Mississippi Valley; D. C. Parman, Uvalde, Tex., research work on animal insects, to extension service in the same subject; Charles F. Stiles, from cereal and forage insect extension work to apicultural extension, Oklahoma; W. W. Yothers, entomological assistant, tropical fruit insects, to extension work (temporarily) in the same subject.

According to *Science*, "Mr. W. Hague Harrington, one of the best known of the older Canadian entomologists, died on March 13 at Ottawa, Canada, at the age of sixty-six years. Mr. Harrington was born in Nova Scotia, and entered the federal civil service at Ottawa in November, 1870, eventually reaching the rank of superintendent of the Savings Bank Branch. He was one of the founders of the Ottawa Field Naturalists' Club, and at one time was president of the Entomological Society of Ontario. In 1894, he was elected a fellow of the Royal Society of Canada. For many years his main interest in life was entomology, and he brought together a large collection of Canadian Coleoptera and Hymenoptera. He was a systematist of recognized standing, and was probably the highest authority on Hymenoptera in the Dominion of Canada. He was a striking example of that class of men who have done pioneer work in natural history in Canada and the United States, while pursuing this work as a hobby rather than as a vocation."

Appointments have been made in the Bureau of Entomology as follows: R. B. Wilson, Cornell University, bee culture in Mississippi; George H. Rae, bee culture, New York; G. H. Gale, Maryland Agricultural College; Dr. Frank Thomas, special field agent, extension work with deciduous fruit insects, Auburn, Ala.; R. L. Clute, Michigan Agricultural College, stored product insects, Gainesville, Fla.; S. E. McClendon, stored product insects, Athens, Ga.; Felix Dabadie, truck crop insects, Louisiana; Miss M. A. Connell, California, truck crop insects, Washington; W. O. Hollister, Kent, Ohio, a graduate of Connecticut Agricultural College, cereal and forage insects, West Lafayette, Ind.; B. L. Boyden, recently resigned, reappointed for extension work with truck crop insects, Oxnard, Cal.; Forrest N. Anderson, Coffeyville, Kan., truck crop insects, extension work in Texas; Clayton J. Foster, deciduous fruit insects, extension work, Houston, Tex.; Leroy A. Shaw, cereal and forage insect extension work, Montana; Roscoe Wells, extension work, insects affecting domestic animals.

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AN UNUSUAL DISEASE OF HONEY BEES[1]

By ELMER G. CARR

An unusual disease of honey bees appeared in an alarming manner in some well kept apiaries in New Jersey and many other states and in Canada the past season (1917). This was not the first appearance of this disorder in the state and it is entirely possible that the same trouble may have appeared in the apiaries of the less observant beekeepers, many times previous to this date. This trouble was first brought to the notice of the department of apiary inspection in June, 1915.

Mr. Charles Schilke of Morganville, Monmouth County, a beekeeper with considerable experience operating about 300 colonies reported a great loss of bees from the hives in one of his yards located near Bradevelt. Thousands of dead were lying and thousands of dying bees were crawling about in the vicinity of the hives, collecting in groups on bits of wood, on stones and in depressions in the earth. The affected bees appeared to be practically all young adult workers about the age when they would normally do the first field work, but all ages of older bees were found. No abnormal condition within the hive was noticed at this time. The brood appeared normal except for quantity.

The apiary was located in a grove of small trees and the hives were quite thoroughly shaded. The stock was good Italians moved the preceding spring from the home apiary a few miles distant. Poisoning was suspected but no definite conclusions were reached. There is no record of the local meteorological conditions at or immediately preceding this time.

[1] This and the following paper were read at the Pittsburg meeting. They were received too late for insertion in the published proceedings.—ED.

The trouble soon ceased but not until it had taken such a number of bees that the apiary was made profitless. Mr. Schilke thought the trouble came from the water supply, either through dew from sprayed plants or from a contaminated watering place. This apiary was moved to another location.

The following season Mr. Schilke's home apiary at Morganville was similarly affected. An investigation was made but nothing new was learned.

Early in July of the past season a report was received that an apiary of twenty-five colonies at Milhurst, operated by Mr. Schilke, was rapidly being decimated by what appeared to be the same trouble that had before been seen.

On July 12th an investigation of this trouble was made by Dr. Headlee, State Entomologist, New Brunswick, Dr. Sturtevant of the Bee Culture Laboratory, Washington, and the writer.

The apiary was located in an orchard of old high trees which partially shaded the hives although there was opportunity for a free circulation of air. The stock was hybrids.

The ground in the vicinity of the hives was covered with thousands of dead and sick bees. Some were feebly moving about, their movements being much like those exhibited by bees benumbed by cold. Others were more active and displayed a nervous haste to get away from the hive but their progress was slow. The dead were distributed all over the ground, no more being immediately in front of the hive than in any other direction from the hive. While there were a very few of the older workers noticed affected, almost all were young bright looking adults apparently about the age when they would take their first flights. While their abdomens were plump as is quite usual with young workers there was noticed little or no undue distention of the abdomen. Neither were any hairless or shiny bees seen.

The bees showed a tendency to collect in groups not only in depressions in the earth which might be due to feebleness but also on slightly elevated objects such as bits of wood and stones. There was also a decided tendency for these groups to be arranged so that the bees faced each other and many were seen touching tongues. Many bees were seen to make vain attempts at flight.

When the affected bees were bursted the abdominal contents were found watery and gave off an unpleasant somewhat pungent odor entirely unlike that coming from a bursted healthy bee. Not only were workers affected by this trouble but also drones and Mr. Schilke claimed that he had seen queens similarly affected.

The brood within the hives appeared to be healthy.

In contradistinction to the bee disorder commonly known as paral-

ysis, in very few cases was there observed any unusual distention of the abdomen. Neither were there hairless or trembling bees noticed nor were the dead bees massed in front of the hive as is usual in paralytic bees. An abnormal condition noticed in the hives was the great abundance of stored pollen and the unusually small amount of unsealed honey in the combs. In some hives the stored pollen amounted to as much as two combs full.

An apiary of Mr. Schilke less than two miles distant located in the full sunlight was only slightly affected.

The apiary of Mr. J. Kridel, less than one mile from the badly affected apiary, in the shade, was also badly affected. The conditions within the hives were practically the same, *i. e.*, a superabundance of pollen and an unusually small amount of unsealed honey. Dead bees from the ground were examined for arsenic with negative results.

The apiary of Mr. J. Errickson in Freehold, four miles from the Schilke and Kridel apiaries, hybrid bees, located in the shade was similarly affected. Mr. Errickson noticed that many bees after repeated attempts succeeded in flying.

Many apiaries in this vicinity were examined, some containing hybrid bees, some Italian, in the shade and fully exposed to the sunlight and all were found more or less affected.

This disease appeared coincidently with a period of "dull" weather when the bees gathered an usual amount of pollen and little or no nectar. With the coming of fair weather the disease disappeared but not until the colonies were so depleted as to be of no value as surplus honey producers. Aside from the bees in this vicinity covering an area not more than seven miles in diameter no reports were received of a like trouble within the state.

From the evidence it was assumed that the bees were suffering from a digestive disturbance caused by a diet containing too large a proportion of nitrogenous matter. In support of this theory is the superabundance of pollen stored in the combs of the infected colonies, not only in these New Jersey apiaries but also in apiaries in New York, Ohio and Ontario, and the disappearance of the trouble upon the coming of weather favorable to nectar gathering. Antagonistic to this theory is the presence of sealed honey in the combs. Huber[1] says capped honey is never used in summer except in case of extreme necessity. If we may assume then that the bees show a great disinclination to uncap sealed honey at this season of the year the theory holds good.

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[1] Huber, F., 1821, "New Observations on the Natural History of Bees," third edition—Edinburgh.

Just what relation the parasite *Nosema apis* may bear to this trouble is not yet proven, but the symptoms in bees affected by this trouble are strikingly similar to the described symptoms of Isle of Wight disease which has been thought to be caused by this parasite.

Imms[1] says "this parasite affects the digestive system and there is an enlargement of the posterior parts of the intestine particularly the colon and rectum" which appears to support the theory of defective digestion. He further says "beekeepers claim to prevent the occurrence of this disease by feeding." This further supports the theory.

The results of the studies of *Nosema apis* by Fantham and Porter[2] appear to coincide with the conditions accompanying this trouble. They state that "the virulence of the parasite (*Nosema apis*) appeared to vary in bees at different times of the year and in different locations." This possibly accounts for the manner in which this trouble appears at widely scattered points.

Fantham and Porter[3] have found *Nosema* in greatest numbers in the chyle stomach and in a lesser degree in the small intestines. The spore stage is the only stage they have proven capable of infecting new hosts.

The observations and experiments by Anderson and Rennie[4] apparently fail to connect *Nosema apis* in any causal relation with Isle of Wight disease. They were unable to convey the disease by contact with contaminated hives or combs or by feeding contaminated stores. They found spores of *Nosema apis* in bees showing no symptoms of disease and the examination of many bees showing the disease revealed no trace of *Nosema apis*. Their observations revealed, usually, only a small per cent of colonies in an apiary affected by disease and aside from one colony of what they called "American goldens," the disease affected one race as readily as another.

In the work at the Bee Culture Laboratory at Washington *Nosema apis* has been found in both sick and apparently healthy bees.

The observations of the various persons mentioned seems to leave considerable doubt as to *Nosema apis* being the cause of the disorder observed. The presence of *Nosema* in bees apparently healthy, might be explained by the work of Fantham and Porter who claim that some

[1] Imms, A. D. (Journ. Bd. Agric., London, 14 [1907], No. 3, pp. 129–140, fig. 3.)

[2] Fantham, H. B., and Porter, Annie. (Proc. Zoöl. Soc., London, 1911, III, pp. 625–626.)

[3] Fantham, H. B., and Porter, Annie, 1914, "Some Minute Animal Parasites," London.

[4] Anderson, J., and Rennie, J., 1915–1916, "Observations and Experiments Bearing on 'Isle of Wight' Disease in Hive Bees." Royal Phys. Soc. of Edinburgh, vol. XX, part I.

bees are themselves immune to the attacks of this parasite but act as carriers of the disease.

If *Nosema* is really the culprit, the failure to find the parasite in bees apparently suffering with Isle of Wight disease is not easily explained.

It is highly desirable that the exact cause for this serious bee trouble be discovered in order that its control be intelligently undertaken. However, until such a time as the cause is known it seems entirely practicable for beekeepers to correct, when possible, any abnormal or unfavorable conditions about the apiary and perhaps decrease if not entirely overcome the harmful effects of this disorder.

FOUL BROOD ERADICATION WORK IN TEXAS

By F. B. Paddock, *State Entomologist, College Station, Texas*

The law under which the foul brood eradication work is being conducted in Texas was passed by the state legislature in 1913. The more outstanding features of this law were discussed by Wilmon Newell[1] before this section at the twenty-sixth annual meeting of the Association. He says, "The result was a law which seems to cover the ground thoroughly and to provide for all contingencies which may reasonably be expected to occur." Under the authority of the law, regulations have been issued from time to time. These deal primarily with the counties in which the eradication work is being conducted, having for their chief aim the necessity for transferring all bees to removable frame hives, and the preventing of the shipment into such counties of any material possibly infected with any contagious bee disease.

The funds with which to carry out the provisions of the law are appropriated by the state legislature. The request for such funds is made by the director of the Experiment Station and this request has the support of the State Beekeepers' Association.

The plan of work is based upon county organizations which coöperate with the state entomologist. When a new county makes a request for work, they are urged to organize a County Beekeepers' Association, and they are given every assistance possible in perfecting such. Then the Association is asked to suggest from its number, three men, who, in their opinion, are capable to serve as county apiary inspector. An examination is then held for these men and the one best qualified to serve is appointed by the state entomologist, subject to the approval

[1] Essentials of a Good Apiary Inspection Law. Wilmon Newell, Jr. Eco. Ent. *VII*, 1, p. 92.

of the director of the Experiment Station and confirmation of the Board of Directors of the College. Sometimes not one of the number proves capable, in which case the County Association can again select from its number for another examination. It is felt that by this means the man best qualified is appointed on merit only. So far the most cordial relations have existed between the County Associations and the state entomologist, and the work of every inspector has been entirely agreeable to all concerned. The foul brood eradication work, by this method, becomes very largely a home industry, and a feeling is built up in each county that demands proper action by every one of the beekeepers. The Association is watching the results of the inspector and demanding action by some few beekeepers as much as is the state entomologist.

The inspectors are paid a per diem of four dollars and an allowance for conveyance. Many of the inspectors use their autos, and encouragement is given this plan, so more of the inspectors are purchasing cars. It is acknowledged that the work can be done more efficiently by the use of a car than by the use of a horse and buggy. The state entomologist is in touch with the inspectors throughout the entire year and they are required to submit a report each month even to show, "No Inspections." The system has developed so that the inspectors are called upon for information of one kind and another, such as general insect reports, honey flora conditions and locality crop reports.

There are now thirty-one quarantined counties in the state. This means that there are thirty-one counties into which no bees, honey or appliances possible of transmitting foul brood can be consigned without an Inspector's Certificate, or a statement from the state entomologist that such goods will be inspected upon their arrival at destination. There are now twenty-four inspectors working in these thirty-one counties.

The presence of the foul brood has been determined in the several counties where the eradication work is not being conducted. It is our hope that we may be able to organize the work in these counties during the coming year. Already the movement is on foot through the Associations where the work is now being conducted, to assist us in organizing the work in adjoining counties. In the past we have preferred to confine our efforts in the eradication work in those counties where the beekeepers were sufficiently interested in the work to organize and coöperate with us. We have had all that we could possibly do with funds available in the organized counties until this year.

The greatest handicap to the work is the ignorance and indifference among a certain class of beekeepers in almost every county in which the work is being conducted. It is expected that this indifferent class

will form a large proportion of the total beekeepers in the unorganized counties. The number of box hives in some of the counties where the inspection work is being conducted, is far too large. There are now a few counties in which no box hives can be found. While the law specifically states that no bees shall be kept in box hives, it seemed inadvisable to force transferring which would necessarily fill the county courts with cases of misdemeanor. We have preferred to take the slower plan of conducting an educational campaign on the value of removing all bees from box hives.

We have found that inspection work cannot go single handed; it must be accompanied with educational work. In two counties we have had especially good results from the campaigns conducted against box hives. In one county in three months 350 box hives out of 1000 had been transferred in movable frame hives. The beekeepers of every county where inspection work is now being conducted, are now realizing the value of the service of the inspector. In many cases the inspectors are receiving more requests for inspection work than they can possibly take care of. An inspector is now considered more than a police officer; he serves very often as an advisor.

The foul brood inspection service has been for the general improvement of the beekeeping industry of the state. We have received letters from all sections which indicate that there has been a general uplift of 50 to 75 per cent in the efficiency of the industry where the work is now being conducted. The inspection work has resulted in a state wide coöperation among beekeepers. In all sections of the state, the beekeepers have come to realize that inspection work is for a common good. Not only have the organizations expressed a desire to coöperate with the state entomologist at all times, but many individual beekeepers all over the state have sought to coöperate in any way possible. There are now very few intentional violations of the law or regulation. The greatest tendency is on the part of honey shippers to disregard the need of certificates in shipping honey. There are some counties where the inspection service is being rendered that do not have foul brood now, and by this action, they are seeking to prevent its introduction. In very few counties foul brood has been eliminated and in many more the disease will be stamped out in a very short time.

CALCIUM ARSENITE AND ARSENATE AS INSECTICIDES[1]

By E. B. Holland, *Associate Chemist*, and J. P. Buckley, *Assistant Chemist*, *Massachusetts Agricultural Experiment Station*

An intensive production of orchard and garden crops the present season will tend towards a maximum consumption of arsenicals in combating leaf-eating insects. A scarcity of lead arsenate, the standard "stomach poison" insecticide, or a prevailing high price will undoubtedly bring into the market other cheaper and less reliable arsenicals such as calcium arsenite and calcium arsenate. The acknowledged requisites for an insecticide that is to be applied as a spray are: non-toxicity as to plant, effectiveness in destroying the insect, adhesiveness or persistence under weather conditions, fineness of particles and low specific gravity to insure a high power of suspension and uniform distribution, ability to indicate the leaf surface covered, and reasonable cost. All arsenical compounds are poisonous, although as a rule the lower or "ite" salts are more active than the higher or "ate" salts. Arsenic soluble in water or which has been rendered soluble by atmospheric agents has a corrosive (burning) action on foliage to the extent of entire defoliation of the plant in severe cases. Therefore an arsenical must be insoluble and stable in water or in whatever vehicle employed to insure its safe application.

Pure calcium arsenite, $Ca(AsO_2)_2$, is a white powder, fairly soluble in water but practically insoluble in presence of excess lime, and contains 77.92 per cent arsenic trioxide. As a farm preparation it was formerly used considerably in the central and western portions of the United States, but recently it has appeared in eastern markets in the form of paste under a trade name. Some years ago Holland and Reed[2] prepared the pure salt and determined its formula and solubility. Spraying tests by the Department of Entomology of this institution showed that it is likely to cause some injury even when mixed with strong (3 per cent) milk of lime. Similar results might be expected when applied with Bordeaux. Calcium arsenite with excess lime has a good power of suspension, the white film readily indicates the leaf surface covered and its adhesiveness provides protection for a reasonable period under average weather conditions. Pure sodium arsenite is a white powder, very soluble in water and contains 76.15 per cent arsenic trioxide. Although offered on the market in solution under a

[1] From the Department of Chemistry, Massachusetts Agricultural Experiment Station. Printed with the permission of the Director of the Station.

[2] 1912, The Chemistry of Arsenical Insecticides. In Mass. Agr. Expt. Sta., Rpt. 24, pp. 194–201.

trade name, its solubility precludes its direct use as a spray but it may serve for the preparation of calcium arsenite by mixing with milk of lime or Bordeaux as directed by the venders. Its use by inexperienced persons cannot be recommended.

Calcium arsenate is manufactured by a number of firms and some experiments have been reported relative to its efficiency. In order to secure more definite information on the subject the Department of Chemistry undertook the preparation of one or more pure salts of calcium and arsenic acid for experimental use by the Department of Entomology. By analogy one might assume that three salts of calcium and of arsenic acid were possible,—the tricalcium, the dicalcium and the monocalcium arsenates as in the case of the phosphates; or at least two salts,—the so-called neutral (tricalcium) and acid (dicalcium) arsenates as in case of lead and arsenic acid. The acid lead arsenate having proved very satisfactory, attention was directed chiefly to the preparation of a similar calcium salt. Precipitation of calcium arsenate from soluble salts of calcium and of arsenic promised the most definite and uniform product as the resulting compound is not recrystallizable. Calcium chloride, neutral and free from other bases forming insoluble arsenates, proved a satisfactory source of calcium (preferable to the acetate), and disodium arsenate, free from arsenite, carbonate and sulfate, a reliable source of arsenic. Previous experience with calcium arsenite indicated that the degree of concentration of the solutions would be a factor in the preparation of the arsenate; unnecessary dilution tends to make difficult precipitation with considerable loss of salt, and too great concentration an unwieldy precipitate with greater occlusion. One-half molecular (M/2) and molecular (M) strength solutions appeared feasible considering the solubility and amount of active agent in each salt, but after considerable preliminary work molecular solutions were found preferable.

Acid calcium arsenate precipitated in the cold from the chloride by an excess (10 per cent) of sodium arsenate generally carries an excess of calcium probably due to the alkalinity of the sodium arsenate and to the failure of the arsenic acid to readily unite with the lime. Heat facilitates the interchange of bases, and arsenic in neutral form is preferable for the excess. Monosodium arsenate is neutral and can be easily prepared from a solution of the disodium by adding the calculated amount of hydrochloric acid. Under these conditions the following reaction may be said to take place:

$$CaCl_2 \,.\, n\,H_2O + Na_2HAsO_4 \,.\, 7H_2O + NaH_2AsO_4 = CaHAsO_4 \,.\, H_2O + 2NaCl + n\,H_2O \quad \text{equal volumes of M solutions} \qquad 10\% \text{ excess}$$

The mixed solutions were heated slowly to 95° C. with agitation, al-

lowed to cool, filtered in a Büchner funnel, washed free from chloride, dried at a low temperature, and weighed. In laboratory practice the recovery on the basis of the original calcium content averaged nearly

ANALYSES OF ACID CALCIUM ARSENATE

	No. 12		No. H 1-7		Theoretical $CaHAsO_4.H_2O$
Character of product	dry powder		dry powder		
Color	white		white		
Shape of particles	rhombic crystals[1]		rhombic crystals[1]		
Size—length[2]	5–32μ av. 19μ		4–28μ av. 17μ		
breadth[2]	2–11μ av. 6μ		2–16μ av. 9μ		
Uniformity[2]	variable in shape and size		variable in size		
Nature of defects[2]	broken crystals		broken crystals		
Amount of defects[2]	50 per cent		1 per cent		
	Air dry, per cent	On dry basis, per cent	Air dry, per cent	On dry basis, per cent	Per cent
Water	.20		.12		
Calcium oxide (CaO)	28.25	28.306	28.30	28.334	28.310
Arsenic pentoxide (As_2O_5)	57.91	58.026	57.955	58.025	58.045
Water of combination	13.65	13.676	13.63	13.646	13.645
	100.01	100.008	100.005	100.005	100.000
Arsenic (As)		37.836		37.835	37.848

[1] For description see Gmelin-Kraut's Handbuch der anorganischen Chemie, Bd. 3, Abt. 2, pp. 568–569 (1908).

[2] Determined by A. I. Bourne of the Entomology Department.

SOLUBILITY OF ACID CALCIUM ARSENATE

	No. 12 per cent	No. H 1-7 per cent
Water	.20	.12
Water soluble (Hilgard method)		
Calcium oxide		22.50
Arsenic pentoxide	50.52	44.82
Solids		74.20
Lime water soluble		
Arsenic pentoxide	.31	.17

86 per cent in spite of innumerable mechanical losses. Attention is called to the analyses of two samples of acid arsenate. No. 12 was produced in the preliminary work and No. H 1–7 drawn from a mixture of seven different laboratory batches prepared for spraying experiments.

Acid calcium arsenate is soluble in water but practically insoluble in lime water, which indicates that its safe application necessitates an admixture with Bordeaux or strong milk of lime. It contains a high percentage of arsenic and may serve in many instances as a substitute for acid lead arsenate during the present emergency. Experiments to test its efficiency are in progress.

FUMIGATION WITH CHLORPICRIN [1]

By William Moore, *Division of Entomology and Economic Zoölogy, Minnesota Agricultural Experiment Station*

Introduction

The discovery that chlorpicrin, although a rather volatile compound,[2] is extremely toxic to insects naturally raised the question as to its possible use in the fumigation of grain and clothing. Its value as a fumigant to destroy the clothes louse [*Pediculus humanus* (*vestimenti*)] and its eggs has been reported.[3] Molecule for molecule it is about 283 times as toxic as carbon bisulphide, which is now in common use as a fumigant of clothing and grain. Carbon bisulphide has the disadvantage of being very explosive. The use of chlorpicrin under normal conditions is without danger, although when heated it may be exploded. Carbon bisulphide, although it has a very disagreeable odor, does not deter people from entering a room containing large quantities of the vapor, and illness and even death may result.

Owing to the severe irritation to the eyes, nose, and throat produced by even very small quantities of the vapor of chlorpicrin in the air, no one would ever enter a room until all the vapor had escaped. One of the chief advantages of carbon bisulphide in the fumigation of grain is that its vapor is about 2.5 times heavier than air and is thus able to sink down through a large mass of grain. Chlorpicrin vapor is about twice as heavy as that of carbon bisulphide. With these advantages in mind the following experiments are of interest.

[1] Published, with the approval of the director, as paper No. 114 of the Journal Series of the Minnesota Agricultural Experiment Station.

[2] Moore, Wm., Volatility of Organic Compounds as an Index of the Toxicity of their Vapors to Insects, Jour. of Agr. Research, vol. X, No. 7, 1917, pp. 365–371.

[3] Moore, Wm., The Control of the Clothes Louse [Pediculus humanus (vestimenti)], Jour. of Lab. & Clin. Medicine, vol. III, No. 5, 1918, pp. 261–268.

Effect of Fumigation on Insects Infesting Grain

Exp. 1. Ears of corn infested with adult saw-toothed grain beetle (*Silvanus surinamensis* Linn.) and pupæ of the Indian meal moth (*Plodia interpunctella* Hbn.) fumigated with chlorpicrin at the rate of one-half pound per 1,000 cubic feet under a bell jar for twenty-four hours at a temperature of 70°–80° F. Insects killed.

Exp. 2. Flour infested with adult confused flour beetle (*Tribolium confusum* Duval) was placed in a battery jar to a depth of three inches. Fumigated under bell jar at rate of one-half pound of chlorpicrin to 1,000 cubic feet for twenty-four hours at a temperature of 72° F. Beetles all killed.

Exp. 3. Flour infested with larvæ and adults of confused flour beetle fumigated as in preceding experiment, but using one pound of chlorpicrin per 1,000 cubic feet for twenty-four hours, temperature 72° F. Adult beetles were killed, but all the larvæ were still alive.

Exp. 4. Corn meal infested with larvæ of Mediterranean flour moth (*Ephestia kuehniella* Zell.) placed in paper flour bag. Flour infested with adult confused flour beetle contained in a battery jar to the depth of five inches. Corn on the ear infested with saw-toothed grain beetle. All fumigated in a wooden box of six cubic feet capacity for twenty-four hours at a temperature of 70° F. using chlorpicrin at the rate of one-half pound per 1,000 cubic feet. Mediterranean flour moth and the adult saw-toothed grain beetles all dead. Confused flour beetles, buried in the flour, survived the fumigation.

Exp. 5. Beans infested with larvæ, pupæ and adults of the bean weevil (*Bruchus obtectus* Say); whole wheat flour with cocoons of Mediterranean flour moth and white flour with all stages of the confused flour beetle. Each was contained in paper bags which were placed in the wooden fumigation box and fumigated with one pound of chlorpicrin per 1,000 cubic feet of space for twenty-four hours at a temperature of 70° F. All the insects were killed.

Exp. 6. Beans infested with larvæ, pupæ and adults of the bean weevil were fumigated as in the preceding experiment, but using one-half pound of chlorpicrin for each 1,000 cubic feet. All insects destroyed.

Exp. 7. Twenty-five and fifty pound sacks of flour infested with all stages of the confused flour beetle were placed in different parts, some near the top, others at the bottom of a wooden fumigation box of 180 cubic feet capacity. These were fumigated with chlorpicrin at the rate of one pound per 1,000 cubic feet for twenty-four hours at a temperature of 70°–75° F. Flour was thoroughly aired and then sifted and the insects examined. They were then placed in the open and reëxamined twenty-four hours later. Both examinations failed to reveal a single live insect. Some of the flour was kept for three months, but no insects developed in it.

Exp. 8. Ears of corn infested with larvæ, pupæ and adults of the Angumois grain moth (*Sitotroga cerealella* Oliv.) were fumigated in the wooden box of six cubic feet capacity with chlorpicrin at the rate of one-half pound per 1,000 cubic feet at a temperature of 55° to 61° F. for twenty-four hours. After thorough airing, examination of the ears showed only dead larvæ, pupæ and adults. The ears were kept for two months and since no further evidence of the moth could be detected 100 per cent must have been killed.

Exp. 9. Beans infested with the bean weevil larvæ, pupæ and adults, and flour infested with confused flour beetle were fumigated in fumigation box of six cubic feet capacity for twenty-one hours at the rate of one-half pound per 1,000 cubic feet. Temperature during fumigation 65°–70° F. All stages of the bean weevil were killed, but the flour beetles deeper than from one and one-half to two inches in the flour survived.

Exp. 10. Flour infested with larvæ and adults of the confused flour beetle contained in a flat glass dish one and one-half inches deep, and beans infested with the bean weevil, contained in a battery jar, were fumigated in the fumigation box of six cubic feet capacity for forty-eight hours with carbon bisulphide at the rate of three pounds to 1,000 cubic feet. Examination after airing showed all the larvæ and adult of the confused flour beetle to be dead, while 100 beans contained one living larva and one adult out of thirty. The temperature during the experiment was 60°–68° F.

From these results it is apparent that one-half pound of chlorpicrin per 1,000 cubic feet will prove destructive to the bean weevil (*Bruchus obtectus* Say), the Angumois grain moth (*Sitotroga cerealella* Oliv.), the Indian meal moth (*Plodia interpunctella* Hbn.), Mediterranean flour moth (*Ephestia kuehniella* Zell.), but is not sufficient to kill the confused flour beetle (*Tribolium confusum* Duval) deeper than an inch in the flour. For this insect it is necessary to use as much as one or two pounds per 1,000 cubic feet. Where the quantity of flour or grain fills the entire space of the fumigation box stronger doses would be necessary. Carbon bisulphide must be used in our fumigation boxes at the rate of from three to eight pounds to produce similar results and the temperature must be above 65° F. In using chlorpicrin the temperature may be below 60° F. and still give good results as in Experiment 8.

Effect of Chlorpicrin on the Germination of the Grain

Table I summarizes the results of the effect of chlorpicrin on the germination of the grain.[1]

Table I

Seed	Check	24 hrs. 2 lbs.	24 hrs. 1½ lbs.	24 hrs, 1 lb.	24 hrs. ½ lb.	48 hrs. ½ lb.
			Each per 1,000 cubic feet			
Rye	82	67				
Oats	82	59				
Wheat	94	90				
Barley	99	98				
Corn	93	95				
Oats	99				97	
Oats	99			97		
Oats	99	93				
Rye	79	30		71		
Corn	90			95	98	
Corn	90	96	95			
Corn	93					92
Wheat[2]	88	60	66	72	81	64
Oats	94	93	95	96	98	92
Rye	99	89	95	96	99	87
Corn	90	96	95	95	98	
Corn	93					92

[1] I wish to thank Mr. Robert Dahlberg of the Division of Plant Pathology and Botany who kindly conducted the germination tests of the grain.

[2] This wheat was a poor grade having been injured by mice.

Small doses such as one-half pound per 1,000 cubic feet of space do not injure the germination of the grain. Large doses do injure the germination if germination is attempted before the grain has had a very thorough airing. Rye with a germination of 99 per cent was fumigated at the rate of two pounds per 1,000 cubic feet for twenty-five hours. A germination test started eight hours after being removed from the box gave 81 per cent; twenty-four hours, 81 per cent; forty-eight hours, 95 per cent; seventy-two hours, 98 per cent. It is also essential that the grain be perfectly dry when fumigated. Navy beans taken directly from the field before thoroughly drying were fumigated at the rate of two pounds per 1,000 cubic feet for twenty-four hours. The fumigated beans and the check were then permitted to thoroughly dry after which their germination was tested. The check germinated 95 per cent while the fumigated beans germinated 5 per cent. Part of the check after drying, similarly fumigated, germinated 94 per cent.

Effect of Chlorpicrin on Flour

In the earlier experiments fumigation with chlorpicrin had a bleaching effect upon flour. When pure chlorpicrin, free from chlorine and nitrogen peroxide, was used, however, no bleaching resulted. Samples of wheat fumigated and unfumigated were converted into flour and it was found that even following the use of chlorpicrin containing the above mentioned impurities no effect was noticed in the color of the flour.

A sample of flour was fumigated with chlorpicrin to test its baking properties. The fumigation was at the rate of two pounds to 1,000 cubic feet for twenty-four hours at 70° F. After fumigation the flour was thoroughly aired for a week after which it was enclosed in a tin box for a month before it was possible for the baking test to be conducted. The results are:

	Volume	Color	Texture	Expansion
Standard................	1,520	100	99	820
Fumigated...............	1,450	100	96	850

The fumigated sample required thirty-five minutes longer for fermentation than the control. The chlorpicrin must either have had some action on the flour enzymes, or a small quantity of the chemical had been retained by the flour, resulting in an inhibition of the yeast, or it left the flour in such condition that the yeast was inhibited. The normal sample showed a water absorption of 58.18 per cent while the fumigated showed 62.40 per cent.[1] The bread, showing no different

[1] The author wishes to express his thanks to Miss Cornelia Kennedy of the Division of Agricultural Biochemistry for the study of the baking qualities of the flour.

taste from the normal, was fed to guinea pigs, rabbits, rats and cats, which ate it and showed no effects.

From these results it is apparent that the chlorpicrin has an influence on the baking qualities of the flour. It would be inadvisable to use chlorpicrin on a large scale for the fumigation of flour, but there may be cases where its use would be advisable and where the insects would do more damage to the flour than the chlorpicrin.

Effect of Fumigation on Clothing

As no insects infesting clothing were available no data can be given of the action of chlorpicrin on these insects. Insects infesting clothing are no more difficult to kill than those infesting grain, hence chlorpicrin should prove effective against insects in clothing if used at the rate of from one to two pounds per 1,000 cubic feet of space.

An effort was made to determine if the action of chlorpicrin would injure different types of cloth or tend to bleach their color. The following list of materials[1] and their colors were fumigated:

1. Lavender	Unknown
2. Rose pink	Ratiné
3. Lavender	Marquisette
4. Blue striped	Silk striped voile
5. Flowered blue and pink	Windsor crêpe
6. Green	Silkine or silk mull
7. Rose	Serpentine crêpe
8. Pink	Mull
9. Brick red	Mull
10. Cerise	Mull
11. Lavender	Silk striped voile
12. Lavender	Flowered Windsor crêpe
13. Pale blue	Ratiné
14. Pale blue	Silk striped voile
15. Dark red	Mull
16. Pink	Unknown
17. Flowered	China silk
18. Gray	Poplin
19. White	Mull
20. Pale blue	Ratiné
21. Copenhagen blue	Palm Beach
22. Gray	Artificial silk and cotton Longtex
23. White	Rep or poplin
24. White	Windsor crêpe
25. Baby blue	Marquisette
26. Yellow pink	Marquisette
27. Pink	Lorraine tissue gingham

[1] The names of materials and their colors were kindly furnished by Miss Clara Brown of the Department of Home Economics.

The chlorpicrin available for the earlier experiments contained a small amount of chlorine and nitrogen peroxide. With this material a slight bleaching of No. 1 and No. 7 was noted. When chemically pure chlorpicrin was used at the rate of two pounds per 1,000 cubic feet no bleaching was observed. Chlorpicrin may, therefore, be used to fumigate clothing, providing it does not contain impurities of chlorine and nitrogen peroxide. Even with the impurities the bleaching was not so great as would result from the washing of either of these materials.

Conclusion

Chlorpicrin cannot, at the present time, be obtained on the market, but the writer has been assured, through correspondence with chemical firms, that after the war it will be possible to manufacture this chemical for about thirty cents a pound in large quantities. Even if retailing for from seventy-five cents to one dollar a pound it would be a cheaper fumigant than carbon bisulphide. These results are published in order that others may try out this interesting compound. Chlorpicrin is a very poisonous compound, hence care should be exercised in its use. Owing to its irritation to the eyes and nasal passages it could never be used on a large scale or where it would be difficult to remove the vapor after the fumigation. It may prove of value in the fumigation of small quantities of grain or seeds, samples of grain such as the agronomist wishes to preserve, for the destruction of ant nests or gophers, while light doses may prove of value for the destruction of mosquitoes in yellow fever regions.

The following points summarize the experiments:

1. Chlorpicrin used at the rate of from one-half pound to one pound to 1,000 cubic feet will destroy insects, which require from three to eight pounds of carbon bisulphide.

2. There is more likelihood of injury to germination than in the use of carbon bisulphide, but with normal doses, if the grain is dry and is thoroughly aired after fumigation, no injury results.

3. Chlorpicrin is able to penetrate through fifty pound sacks of flour in twenty-four hours at a temperature of 70° killing all the insects.

4. Chlorpicrin has a slight injurious influence on the baking qualities of flour.

5. Chlorpicrin free from impurities of chlorine and nitrogen peroxide will injure neither dress materials nor their color.

NOTES ON THE POISONOUS URTICATING SPINES OF HEMILEUCA OLIVIÆ LARVÆ[1]

By D. J. Caffrey, *Scientific Assistant, Cereal and Forage Insect Investigations, Bureau of Entomology*

Introduction

While making a preliminary study on the New Mexico range caterpillar (*Hemileuca oliviæ* Ckll.), Mr. C. N. Ainslie[2] noted that the larvæ were clothed with urticating spines, apparently as a means of protection against some of their natural enemies. Since his observations were made and during the course of further work on the control of this caterpillar, some interesting and important points have been observed concerning the poisonous effects of these spines borne by the larvæ of this species.

Location and Dispersion of Spines

The urticating spines are borne in clusters along the subdorsal portion of segments 3 and 4 (mesothorax and metathorax) in the second and third instars, and in clusters along the sub-dorsal, lateral and subventral portions of segments 2 to 12 in the remaining instars. Although the spines are first developed in the second instar, their presence is not particularly noticeable until the fourth instar is reached. During the fourth and succeeding instars, it is very difficult for a susceptible person to come into contact with the larvæ without becoming painfully injured. The same is true of the pupæ and cocoons, as the urticating spines from the last moulted skin of the larvæ apparently are caught in the silken threads of the cocoon during the process of pupation, thus rendering these objects almost as difficult to handle as the larvæ.

Accumulative Nature of the Poisonous Agent

A notable fact, concerning the poisonous substance contained in the urticating spines, was that during the first season, the large *H. oliviæ* larvæ could be handled with safety by most persons starting in to work with the species. After a short time, however, and generally during the second summer of work, it became impossible for these same persons to handle *H. oliviæ* larvæ, which had advanced beyond the fourth instar, without the protection of gloves. It was a common occurrence for the new men to ridicule the more experienced workers for wearing

[1]Published by permission of the Secretary of Agriculture.

[2] Ainslie, C. N., U. S. Dept. of Agr., Bureau of Ent., Bulletin 85, Part V—The New Mexico Range Caterpillar—pp. 76–77.

gloves, but during an association with about ten different individuals, the writer never has observed an instance when complete immunity from the poisonous effects of the spines extended through the second season of work. It thus will be noted that the effect of the poisonous substance, contained in these urticating spines, appears to be accumulative rather than to cause any degree of individual immunity by continual contact with the poison. This characteristic is very similar to that occurring in the case of the Brown Tail Moth (*Euproctis chrysorrhœa*).

Character of Injury

The character of the injury caused by the urticating spines of *H. oliviæ* may be either external or internal.

External Injury. The most common external injury is that which is inflicted upon the tender portions of the tissue immediately surrounding the finger nails. The larvæ appear to fully appreciate the value of the spines as a means of defense, for when grasped in the fingers, they immediately begin to twist their bodies convulsively with the apparent object of driving the spines into the flesh. When this result is accomplished, the wounded portion is first affected by an intense itching and smarting, soon followed by a white swelling. This swelling remains for several hours and then usually subsides, only to return, accompanied by the same intense itching each time this portion of the skin comes in contact with any object. Apparently each time the wounded part is touched or irritated, the poisonous agent is stimulated into activity. The tough skin at the ends of the fingers is more resistant than any other exposed part of the body, but when once penetrated, an exceedingly painful wound is made, although only a minimum amount of swelling results. It often was necessary to transfer men, who had suffered such injury from the effects of these spines, to other work until the effects of the poison subsided.

The most painful and pronounced injury occurs when the large larvæ come into contact with the tender skin on the back of the hand, on the fore-arms, ankles or other unprotected parts of the body. On one occasion, the writer had the misfortune to bring the back of the right hand directly down upon a large sixth instar larva which was crawling along one of the insectary benches: an intense itching and smarting at once began, followed by a pronounced swelling. This did not subside, as is ordinarily the case, and the next morning the swelling had extended to the wrist; the entire hand being about one-half larger than normal, the knuckles appearing as sunken pits, and the surface of the hand smooth and shiny. A sort of numbness and dull pain was felt throughout the member, there being, however, no sensation of itching or smarting. A physician was consulted who applied strong

tincture of iodine in a band around the wrist, also painted the entire back of the hand with a weaker tincture of the same chemical. This treatment had the effect of arresting the swelling. The spot where the larval spines had entered the flesh became septic, due perhaps to the blistering effects of the iodine used, and the hand did not return to normal for more than a week.

Another instance showing the extremely active effects of the poison may be cited in the case of a man who climbed from the seat of his automobile in order to open a gate between two range pastures, which were infested with larvæ of *H. oliviæ.* This man happened to be wearing low shoes and thin socks, and probably brushed against a caterpillar clinging to a blade of grass. After returning to the automobile, he was conscious of a sharp stinging pain in his ankle, and upon removing the shoe and sock, observed a white swelling. He at once became very much alarmed and concluded that he had been bitten by a rattlesnake, as these reptiles are very numerous in this vicinity. It was only after an examination by a physician that he became convinced that he was not the victim of a snake bite.

During the course of investigations, many similar experiences of poisoning by *H. oliviæ* larvæ were related by the cattlemen and dry-land farmers who inhabit the infested region.

The eyes of the men working with the larvæ were often affected by the urticating spines, a severe inflammation and swelling being the usual result. This was probably due to the fact that the spines were either floating in the air or were carried to the eyes by the fingers or gloves which had become infested with the spines and were then carelessly used to rub the eyes.

Internal Injury. The internal injury caused by the urticating spines of *H. oliviæ* is of a much more serious nature than the external injury. While engaged in rearing predaceous beetles, it became necessary to collect and confine in screen-covered boxes large numbers of the larvæ of *H. oliviæ* to serve as food for these beetles. Five or six hundred larvæ were sometimes confined in a small box, and because of their constant crawling about and rubbing against each other, the urticating spines apparently became detached and floated in the air. While transferring this material or working in the vicinity of a cage containing the same, these spines often entered the respiratory tract during the process of breathing. The first effect of taking them into the system was an oft-repeated and painful sneezing, accompanied by an excessive watery discharge and soreness of the eyes and nasal passages. These symptoms rapidly developed into a condition worse than ordinary hay fever or bronchitis, the spines apparently irritating the bronchial tubes, rendering breathing

difficult and imparting a strong acrid taste to the mucous expelled. In more advanced cases, typical asthma resulted. At first these attacks were attributed to ordinary hay fever until it was noticed that the attacks continued long after the early frost had killed the flowers that are commonly blamed for this malady. Some individuals were affected more than others, but as a rule, those who had been working with the species for the longest period were affected the worst.

In attempting to recover pupal parasites, a great many pupæ, inside their cocoons, were collected each autumn and placed in paste board box cages, from which a glass vial protruded. From the pupæ not parasitized, adults often emerged and thrashed about inside the cage, instead of finding their way into the glass vial. In this manner, the interior of the cage became thickly strewn with hairs from the bodies of the adults and with the urticating spines from the last moulted skins of the larvæ, which had been entangled in the cocoons. When cleaning this type of cage or examining its contents, these hairs and spines floated in the air and caused the same affliction as previously described when handling the larvæ. During the last two seasons, the writer found it absolutely necessary to moisten the interior of these cages before working with them. On several occasions, when this precaution was not taken, a severe attack of bronchitis and asthma was the ultimate result.

To illustrate, on one occasion during late October, 1916, at a time when the writer was feeling perfectly healthy and normal in every way, one of these cages was examined without taking the precaution of moistening its contents. Within a few seconds, the air in the vicinity of this open cage became extremely irritating; soon sneezing and coughing began, with excessive watering of the eyes and nasal passages, continuing at intervals until bedtime. The next morning the bronchial region felt sore and contracted (the sneezing had stopped), and great difficulty was experienced in breathing, the same being accompanied by a wheezing noise. The point is again emphasized that this change had taken place within a period of twelve hours. The asthmatic condition grew rapidly worse and necessitated the services of a physician for several days before relief was finally obtained.

Several men connected with the *H. oliviæ* investigations have suffered with these attacks during the past three years, and it has been noticed that each attack appears to be of greater intensity than the preceding one. This tendency will probably render it imperative that susceptible individuals avoid all contact with *H. oliviæ* and, in order to secure immunity or relief in cases of this kind, it may even be necessary to transfer these individuals from that part of the country where

the species exists, as has been found necessary under similar conditions in Brown Tail Moth investigations.

Effects of Urticating Spines on Animals

It was often noticed that small areas of good grazing grass in infested pastures were left untouched by the animals. An examination of these untouched areas generally showed that the grass was infested by the urticating spines shed by the larvæ in the process of moulting. This was evidenced by the fact that upon running the fingers through this grass, the characteristic itching and smarting was experienced. From the facts previously given, the ill effects of these spines on the tender mouth of any animal grazing upon infested grass of this character, can readily be imagined, and it is not strange that the range animals soon learn to avoid all grasses in the vicinity of *H. oliviæ* larvæ. This fact is an important item in the total loss occasioned by the pest.

Urticating Spines of Closely Allied Species

Larvæ of the two closely allied species, *Hemileuca nevadensis* Stretch and *Hemileuca sp.* (*maia* variety ?) Busck, both of which occur in this region, were observed to have the same poisonous properties as have been noted under *H. oliviæ*. The larvæ of *H. nevadensis* feed upon willow along the banks of the Red River in northeastern New Mexico and the larvæ of *Hemileuca sp.* (*maia* variety ?) feed upon scrub-oak along the mesas and foothills of the same region.

Conclusion

From the foregoing, it will be noted that the urticating spines of *H. oliviæ* are a source of danger and discomfort to people coming in contact with the species. The effect of the poisonous agent in these spines appears to be accumulative in its nature rather than to confer any degree of immunity through continual contact.

The injury may be internal or external. The external injury varies in severity according to the part of the body affected, and may lead to partial disability for short periods. The internal injury is more severe than the external injury, and in advanced cases, may result in typical asthmatic symptoms or other disorders of the respiratory tract.

The urticating spines from the moulted skins of the larvæ become scattered through the range grasses and render small areas unfit for grazing.

THE LIFE HISTORY AND HABITS OF CHLOROPISCA GLABRA MEIG., A PREDACEOUS OSCINID (CHLOROPID)

By J. R. Parker, *Assistant Entomologist, Montana Agricultural Experiment Station*

While a majority of Oscinid (Chloropid) larvæ are vegetable feeders several exceptions to the habit have been noted. Coquillett reared *Gaurax anchora* Loew. from the egg shells of *Corydalis cornutus* Linn. and observed that the larvæ of this species would also feed upon the molted larval skins and chrysalis shells of *Hemerocampa leucostigma* S. & A. He also reared *Gaurax araneæ* Coq. from an egg sac of *Argiope riparia* Hentz. The same worker reared *Madiza oscinina* Fall. from the egg sac of a spider. More recently Jones[1] has described a new species, *Botanobia darlingtoniæ*, the larvæ of which feed upon dead insects caught by the California pitcher-plant (*Darlingtonia californica* Torr.).

While the scavenger habit is apparently quite well developed in the Oscinidæ, to the best of the writer's knowledge no species in the family has been reported heretofore as predaceous. An account of the habits of *Chloropisca glabra* Meig. showing that the larva is predaceous upon the sugar-beet root louse (*Pemphigus betæ* Doane) is, therefore, of interest not only on account of its economic importance but because it records a habit new to this important group of insects.

The development of the predaceous habit within the vegetable feeding family Oscinidæ is forecasted by the exceptions noted above. Larvæ of *Gaurax anchora* feed upon molted insect skins; larvæ of *Botanobia darlingtoniæ* advance closer to the predaceous habit by feeding upon the dead bodies of insect victims of the pitcher-plant; by killing its own victims, *C. glabra* goes one step further and become truly predaceous. It is also possible to conceive that the predaceous habit in this last species has been comparatively recently acquired. When the species was first evolved it may have fed upon the roots of the host plants of *Pemphigus betæ;* later it may have developed a liking for cast skins and the bodies of fungus killed aphids which it would meet continuously among the host plant roots; once having acquired a taste for the body contents of the underground aphids it would have been a very simple matter to include within its diet the slow moving, living root louse with which it was so closely associated.

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[1] Jones, Frank Morton. Two insect associates of the California pitcher-plant, *Darlingtonia californica*. Entomological News, v. 27, no. 9, p. 389–392, 1916.

Historical

Very little has been written concerning the life history of *C. glabra*. In Europe Kühn[1] in 1887, found caraway plants attacked by mining insects and reared *C. glabra* from puparia found in the ground below the plants. He apparently infers that the larvæ mining the leaves were of the same species as the puparia taken from the soil. Several notes on the larval habits of *Chlorops assimilis* Macq. now considered a synonym of *C. glabra*, are given by Coquillett[2] as follows: "On July 26, 1884, Mr. Theo Pergande found two larvæ and one puparium of this insect among a colony of aphids on the roots of *Poa pratensis*. One of the flies issued on the 31st of the same month." "On September 6, 1892, several sugar-beets were received from the W. B. Sugar Company, of Castroville, California, and in the leaves were found a number of the puparia of this insect. The adult flies issued two days later." "Larvæ and puparia of this species were taken September 1, 1897, by Messrs. F. H. Chittenden and F. C. Pratt in the earth about the roots of horse radish in the vicinity of Tennallytown, D. C. Several adults issued a few days later."

To Professor J. M. Aldrich, who is making an extensive study of the Oscinidæ (Chloropidæ), I am indebted for the statement that while *C. glabra* is a very abundant species throughout this country and occurs in Europe, Africa and South America, little is known concerning its life history.

In the fall of 1908 Professor R. A. Cooley found puparia of a dipteron in sugar-beet root-louse colonies at Bozeman and he suggested in the original record note that it might be an enemy of the root louse. Adults emerged the following spring and were identified by Coquillett as *Chlorops assimilis* Macq. (*C. glabra*).

Throughout the study of the sugar-beet root louse which was undertaken as an Adams project in 1909, larvæ and puparia of *C. glabra* were found in abundance during the late summer and fall in root-louse colonies and it was suspected from the beginning that it was predaceous upon the root lice. In hundreds of field observations, however, we were never able to actually see the larvæ attack living lice nor feed upon dead lice and as no other member of the Oscinidæ was known to be predaceous, we hesitated to class it as a root-louse destroyer without more definite knowledge. In 1916 a detailed study of *C. glabra* was undertaken,[3] the results of which are embodied in this paper.

[1] Kühn, Julius. Separat Beiblatt des Berliner Tageblatt, No. 9, p. 265, 1887.

[2] Coquillett, D. F. On the habits of the Oscinidæ and Agromyzidæ reared at the United States Department of Agriculture—Division of Entomology. Bul. 10, new series, p. 70–72, 1898.

[3] Mr. A. L. Strand, a careful student assistant, was in charge of the rearing experiments. He devised the improved rearing cage and made many of the observations recorded in this paper.

Rearing Methods

To obtain eggs, adults reared from puparia and later others collected in the open were enclosed with a potted Chenopodium plant in a large lamp chimney cage. The lamp chimney was at first pressed into the soil and the top covered with a piece of cheese cloth. This did not prove satisfactory as moisture collected on the inside of the chimney in large drops in which the flies were continually getting wet after which they would stick to the glass and finally die. To overcome this the chimney was raised from the dirt on a three inch cylinder of fine brass screening and the top was closed by a square of screening held in place by a small weight which hung down into the top of the chimney. In the brass screening around the base a small hole was cut into which was inserted a piece of glass tubing plugged with cotton. This cage allowed air to circulate freely, prevented moisture from condensing on the inside of the chimney, and provided an easy way of introducing adults without disturbing those already in the cage. The screen at the top could be very easily removed and there was no danger of the breaking of elastic band or slipping of string as sometimes happens with cheesecloth coverings.

Eggs were hatched and larvæ were reared in round tin boxes one and one-half inches in diameter and one-half inch deep. These were half filled with plaster of Paris, which provided a smooth, velvety, moisture retaining surface. Several sprouting Chenopodium seeds, five large sugar-beet root lice and one maggot were generally placed in each box. The small rootlets sent out by the sprouting seeds were fed upon by the root lice, which in turn were fed upon by the maggot. The contents of each box were examined daily under the binocular microscope and additional root lice added to bring the number up to five. A few drops of water added to the plaster of Paris each day kept the seedlings growing and brought about moisture conditions in the box closely approaching conditions found in moist soil.

First Appearance of Adults

The adults emerge from overwintering puparia during May and early in June. The earliest appearance noted was on May 19, 1915, when newly emerged adults were seen in a sugar-beet field at Edgar, Montana. On May 22, 1911, large numbers were seen crawling about on the surface of the ground in a sugar-beet field at Bozeman. The field had been soaked by recent rains and the day was warm and bright, conditions which seem to hasten the emergence of the adults. When the newly emerged adults reach the surface of the ground their wings are unexpanded and they crawl about for some time before becoming able to fly.

In the spring of 1916, 360 puparia were collected from the soil in a sugar-beet field and placed in small rearing cages. Some were placed in a green-house and others were kept out-of-doors. Those in the greenhouse began to emerge on May 27, the period of emergence continuing about a week. Those placed outdoors began to emerge on June 3 and continued to appear in small numbers until June 14, on which date thirty emerged. Only two or three emerged in the cages after this date. On June 15 adults were abundant outdoors, five specimens being taken in the first six sweeps of a net over lawn grass. On this date a search was made for puparia in the soil, but none could be found that had not emerged.

After emergence the adults seek grassy or weedy places, being especially attracted to those that are slightly shaded. In collecting over lawn grass bigger catches are always obtained in the vicinity of shrubbery and trees. While the majority of the adults remain in the grass and weeds many of them can be seen crawling over the foliage of shrubbery and trees.

Copulation

Copulation apparently does not take place until several weeks after the emergence of the adults. On two occasions hundreds of newly emerged adults were observed for several hours during which time no attempts at pairing were witnessed. Adults were kept under observation in the insectary throughout the season and copulation was not noticed until the first week in July. The flies remain paired for several hours.

Oviposition

Successive lots of adults taken by sweeping lawn grass were introduced into breeding cages throughout the summer in the hope of securing the egg and larval stages. Although the cages were carefully watched no eggs were secured until July 22. On the morning of this date eight eggs were found in the fine dirt in the bottom of a cage in which twenty-five adults had been introduced the previous day. An effort was immediately made to observe egg laying outdoors, but it was not until a week later, July 29, that the egg laying process was witnessed. By crawling on hands and knees it was possible to approach within a foot of a Chenopodium plant upon which several adults were crawling about. After a long period of aimless wandering one of them crawled down around the base of the plant, backed toward a crack in the soil, in which the abdomen was inserted and an egg deposited. She then walked to a lump of dirt upon which she rested for about thirty seconds when the process was repeated. Eight eggs were in this manner placed near the base of the plant and then six were de-

posited in a crevice about two inches away from the plant. Several other females were noticed ovipositing on this date and the process was observed a number of times during the summer. The flies are easily disturbed and much care and patience must be exercised in order to observe oviposition.

The eggs are deposited around the base of sugar-beet plants and *Chenopodium album*. Occasionally an egg is found attached to the stem of the plant, but the great majority are deposited in crevices in the soil. Chenopodium occurs most frequently as isolated plants growing in soil that has been recently stirred or cultivated. Thus in reaching both the sugar-beets and Chenopodium the flies leave the grassy areas where they have been since spring and often fly considerable distances to deposit their eggs.

Ability of Females to Select Plants Infested with Root Lice

The females in selecting plants around which to deposit eggs show remarkable ability in picking out the plants which are infested with root lice. Two Chenopodium plants of the same size and appearance and standing about two feet apart were examined for eggs. Around the base of one plant only one *C. glabra* egg was found while from beneath the other 224 eggs were collected. When the latter plant was dug up an unusually heavy infestation of root lice was found while the roots of the first plant had no lice upon them. To determine whether *C. glabra* females could consistently pick out the plants infested with root lice a number of Chenopodium plants were examined with results as shown in the following table:

Table I. Showing that Chloropisca glabra Eggs Are Deposited in Numbers only upon Plants Which Are Infested with Root Lice

Plant number	No. of *C. glabra* eggs	No. of root lice	Plant number	No. of *C. glabra* eggs	No. of root lice
1	2	None	17	10	Many
2	1	None	18	50	Very many
3	1	None	19	0	None
4	0	None	20	0	None
5	1	None	21	0	None
6	0	None	22	16	Many
7	39	Many	23	1	None
8	3	Few	24	2	None
9	1	None	25	73	Very many
10	224	Very many	26	36	Many
11	5	Many	27	0	None
12	0	None	28	1	Many
13	0	None	29	0	None
14	0	None	30	17	Many
15	0	None	31	61	Very many
16	3	Few	32	0	None

Number of Eggs

Egg laying records of isolated females were not made. Dissections of 30 females having the abdomen filled with well developed ova were made. The least number of eggs found in one specimen was 32, the largest number 64 and the average was 52.

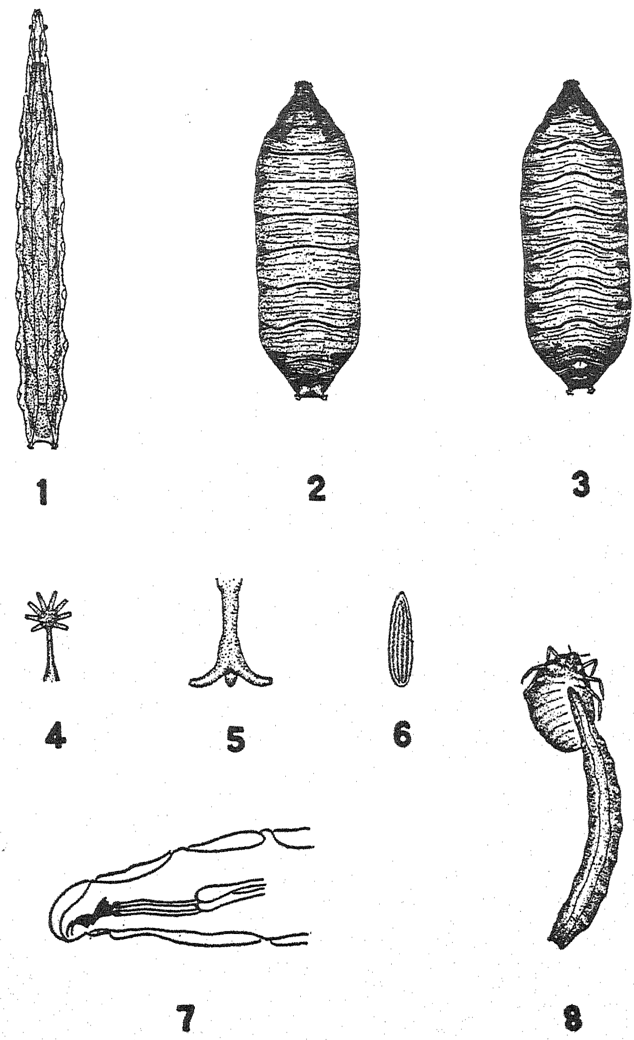

Fig. 14. *Chloropisca glabra* Meig. 1, Larva; 2, Puparium, dorsal view; 3, Puparium, ventral view; 4, Anterior spiracle of larva; 5, Anal spiracle of larva; 6, Egg; 7, Cephalo-pharyngeal skeleton; 8, Larva feeding upon sugar-beet root louse. All figures greatly enlarged.

Description of Egg

Fusiform, more tapering toward the anterior end, slightly curving; rice white; .50 to .75 mm. long and .15 to .20 mm. in width. The chorion is longitudinally grooved and is finely reticulated throughout. The reticulation along the ridges is somewhat coarser and at the posterior end is a much coarser network within which is included a group of finer markings.

Period of Incubation

Two eggs deposited in the breeding cage August 10 hatched August 13; eight eggs deposited August 7 hatched August 12. Eggs collected in the open at various times invariably hatched in 1 to 5 days. The incubation period is, therefore, from 3 to 5 days, and possibly longer during cold, wet weather.

Habits of Larva

The larva upon hatching is a tiny, translucent maggot, about 1.0 mm. in length. In the rearing boxes newly hatched larvæ were not observed to feed until the second day. The maggots are extremely sensitive to light or any disturbance of their surroundings. They will not feed when exposed to light and will stop feeding the moment they are disturbed in any way. This sensitiveness makes it almost impossible to observe their feeding habits in the field and in the hundreds of field observations of root-lice colonies *C. glabra* larvæ have never been detected attacking or feeding upon root lice. When confined with root lice in small, tin boxes, the maggots feed quite readily and by suddenly removing the covers can be seen for a moment in the act. The point of attack is generally on the side of the first segment of the abdomen and more rarely on the ventral surface. The head is inserted well into the aphid and the soft body contents are sucked out. If not disturbed feeding is continued until nothing but the empty skin remains. Only full grown or nearly mature root lice are attacked, possibly because the smaller lice are more active.

Length of Larval Stage and Number of Aphids Devoured

The records of seven maggots hatched from eggs deposited in the breeding cage, reared in tin boxes and supplied with five large aphids per day are shown in the following table:

TABLE II. RECORD OF SEVEN CHLOROPISCA GLABRA MAGGOTS HATCHED AND REARED INDOORS AND SUPPLIED WITH FIVE LARGE ROOT LICE EACH DAY

Serial number	Eggs deposited	Eggs hatched	Number of root lice devoured per day													Total root lice devoured	Length of larval period	Daily average
			Aug. 13	14	15	16	17	18	19	20	21	22	23	24	25			
1	Aug. 7	Aug. 12	1	2	2	3	3	2	3	2	2	1	0	p		21	12	1.8
2			0	2	3	2	2	2	2	4	0	4	2	0	p	23	13	1.8
3			0	1	3	3	2	1	4	3	2	3	3	2	p	27	13	2.1
4			0	1	2	4	3	2	3	2	3	4	4	3	p	31	13	2.4
5			0	2	1	3	2	2	2	3	3	3	0	p		21	12	1.8
6			1	3	4	5	4	2	2	0	p					21	9	2.3
7			2	4	4	5	4	4	5	0	p					28	9	3.1

p=pupated.

The records of six large maggots brought in from the field and supplied with five large aphids per day are as follows:

Table III. Record of Six Apparently Mature Chloropisca glabra Maggots Brought in from the Field and Reared on Limited Food Supply

Larva No.	Number of aphids devoured per day										Total aphids devoured indoors	Total days indoors before pupation	Daily average
	Aug. 8	9	10	11	12	13	14	15	16	17			
1	3	4	3	5	4	2	5	0	0	Pupa	26	9	2.9
2	4	3	4	1	0	Pupa					12	5	2.4
3	0	0	4	2	0	Pupa					6	5	1.2
4	2	0	3	1	4	3	3	Pupa			16	7	2.3
5	5	4	0	0	0	Pupa					9	5	1.8
6	5	3	3	0	Pupa						11	4	2.8

The records of six large maggots brought in from the field and supplied with twenty large aphids per day are as follows:

Table IV. Record of Six Apparently Mature Chloropisca glabra Maggots Brought in from the Field and Reared on Plentiful Food Supply

Larva No.	Number of aphids devoured per day								Total aphids devoured indoors	Total days indoors before pupation	Daily average
	Aug. 11	12	13	14	15	16	17	18			
1	5	8	7	9	8	10	5	Pupa	52	7	7.4
2	5	6	8	4	8	7	6	Pupa	44	7	6.3
3	6	4	4	5	Pupa				19	4	4.8
4	1	2	6	4	4	1	Pupa		18	6	3.0
5	2	6	6	5	4	Pupa			23	5	4.6
6	2	8	8	1	1	6	Pupa		26	6	4.5

From the above data the length of larval life appears to be quite variable. Larva kept in tin boxes indoors from the time of hatching completed their growth and pupated in from 9 to 13 days while several apparently mature maggots brought in from outdoors continued to feed indoors for 9 days before pupating. The length of the larval period in the field probably varies from 10 to 20 days.

The number of aphids devoured by a single maggot apparently varies according to the supply and accessibility of the aphids. Three maggots were able to complete their growth and pupate on a food supply of only 21 large aphids per maggot, while another maggot after it was apparently full grown consumed 52 aphids! It is probable that maggots under natural conditions in root-louse colonies where food is always within their reach would each consume as many as 75 aphids.

Description of Larva

The larva when full grown averages 6.5 mm. in length when alive in normal position. After being killed by dropping in hot water the body becomes distended and averages 7.2 mm. in length. From its greatest width of .7 mm. at the ninth and tenth segment, the body tapers to .5 mm. at the posterior end and to .2 mm. at the anterior end; it is sharply truncated posteriorly; segmental divisions are marked by faint transverse striæ. The anal spiracles are prominent, extending 1 mm. above body surface, three armed, each arm having a distinct opening. Anterior spiracles smaller, only slightly raised above surface of body, seven branched. Connecting the anterior and posterior spiracles are two large tracheal trunks, which can be easily seen through the body wall, and which are bridged by a cross trunk on the last body segment. The black cephalo-pharyngeal skeleton consists of two heavily chitinized rods ending in sharp, strongly curved hooks. A joint in the rods just behind the base of the hook allows freedom of motion.

In color the larva varies from white to a very pale yellow, depending somewhat on the contents of the alimentary canal.

Pupation

The first signs of approaching pupation are inactivity and a shortening of the body. The larval skin is not shed but becomes the outer covering of the puparium. When the puparium is first formed it is white in color and through its transparent wall the tracheal trunks can still be seen. In a short time the color changes to yellow, then to a light tan and finally to a deep brown. Pupation is completed about 36 hours after the larva begins to shorten.

Length of Pupal Period

The pupal period generally extends from some time in August or September until the following May, a period of about nine months, but a few individuals may emerge during the same season in which the puparia are formed, remaining in the pupal stage only two or three weeks. The following table shows the length of the pupal stage in five overwintering and five fall-emerging puparia:

Table V. Showing Length of Chloropisca glabra Pupal Stage

Serial number	Pupated	Emerged	Length of pupal stage
1	Aug. 17	May 29	282 days
2	Aug. 13	May 28	285 days
3	Aug. 15	June 2	287 days
4	Aug. 12	June 3	291 days
5	Aug. 13	May 29	286 days
6	Aug. 14	Aug. 30	16 days
7	Aug. 14	Aug. 31	17 days
8	Aug. 9	Aug. 29	20 days
9	Aug. 13	Aug. 31	18 days
10	Aug. 12	Sept. 1	20 days

Description of Puparium

The puparia average 5 mm. in length and 1.25 mm. in width. Both the posterior and anterior spiracles are present in practically the same form as in the larval stage. The surface of the puparium is grooved by wavy transverse lines. The thoracic and abdominal segments are indicated by deeper grooves in which the coloring is decidedly darker. Along each side are seven narrow, oval depressions, occurring at the segmental divisions and enclosed by dark brown lines.

Hibernation

C. glabra hibernates as a puparium in the soil where the larva completed feeding. The puparia become increasingly abundant during late August and September and by the last of October no other stage can be found. Repeated examinations of root-louse colonies in the late fall and early spring have failed to give evidence of hibernation in any form other than the puparium. A large proportion of the puparia hibernate successfully. Out of 360 puparia collected early in May, 266 or 74.4 per cent, transformed to adults.

Seasonal History

The adults emerge from overwintering puparia during a period extending approximately from May 15 to June 15. Adults are abundant in the open from June 1 until late in September. During the last of August they become scarce in lawn grass but are abundant in the vicinity of sugar-beets and Chenopodium.

In 1916 the first eggs were found in the breeding cage July 22, and outdoors July 29. Eggs were plentiful throughout the month of August. On September 5, only empty egg shells could be found and dissections of females indicated that egg laying was practically over. Out of 25 females examined on this date only 2 contained eggs.

Larvæ were first observed indoors on July 25 and outdoors August 2. In observations of sugar-beet root-louse colonies during the last seven years the maggots have never been noticed in abundance in the field until the middle of August.

The larvæ were at the height of their abundance during the last week of August. Practically all the larvæ had pupated by September 21, although several maggots were found during the month of October.

The first puparia were obtained indoors August 12 and outdoors August 21. On the latter date upon examining the crowns and roots of Chenopodium plants all stages of the fly were found; eggs about the crowns; all sizes of larvæ and occasional puparia among the roots. From this date the number of puparia gradually increased. During the first week in September about as many puparia as larvæ could be

found but from this time on, the number of puparia rapidly increased until September 21, when practically nothing but this stage could be found. None of the puparia obtained in the breeding boxes during August emerged until the following spring.

All of our studies carried on in 1916 indicate that at Bozeman *C. glabra* is single brooded. However, in repeating part of the rearing work in 1917 it was found that in that year at least, a partial second brood occurred.

On August 8 and 10 fifty newly transformed puparia were collected from about the roots of Chenopodium growing in a compost heap. By August 28 forty-five adults had emerged.

Twenty-six puparia were also collected on August 10 from about the roots of Chenopodium growing in ordinary soil. From these three adults emerged September 2. The remaining puparia appear to be perfectly normal and are being held in an outdoor rearing cage.

Fifty large maggots were collected on August 11, isolated in rearing boxes and each supplied daily with 20 root lice. At the end of seven days 42 had transformed to puparia and 8 had died. By September 2 five adults had emerged; the remaining puparia all seem to be alive and apparently will pass the winter in this stage as did all the individuals reared in 1916.

With the above exceptions, *C. glabra* is considered as single brooded at Bozeman. The main reasons in support of this statement are as follows:

1. Adults continue in about the same numbers throughout the summer, disappearing gradually during September.
2. Larvæ never appear in abundance until August and always diminish rapidly during September.
3. Puparia do not reach their maximum abundance until September.
4. Puparia collected at any time during one season seldom emerge until the following spring.
5. Females which emerge in the fall have the ova only slightly developed. Considering that females which emerge in May do not lay eggs until July it does not seem probable that the few adults which may emerge about September 1 could reproduce before being killed by the fall frosts.

In warmer sections of the country, and at lower altitudes it is quite probable that *C. glabra* is double brooded. This is indicated by Coquillett's rearing notes already referred to.

Economic Importance

C. glabra in Montana is by far the most effective insect enemy of the sugar-beet root louse (*Pemphigus betæ*), which in turn is the worst pest with which the sugar-beet growers of Montana have to contend.

Hundreds of puparia have frequently been found in the soil around a single sugar-beet which means that large numbers of root lice have been destroyed. The larva is particularly efficient in that it concentrates its efforts on destroying only well developed root lice, thus preventing the birth of young root lice that would soon increase to enormous numbers. It is not uncommon to find a large number of puparia in the soil around a sugar-beet plant with only the empty skins and secretions of the root lice to indicate their former abundance.

It is certain that *C. glabra* larvæ act as a very important check upon the increase of sugar-beet root lice and in many instances destroy entire colonies.

NEW GALL MIDGES (DIPT.)

By E. P. Felt, *Albany, N. Y.*

The species described below comprise some unusual forms, especially the presumably predaceous *Mycodiplosis packardi*, which closely simulates the associated *Retinodiplosis albitarsis*, the latter with a most interesting larva. The types are in the New York State Museum.

Allomyia n. g. The presence of circumfili, toothed claws, a third vein uniting with costa at the apex of the wing, triarticulate palpi and thirteen antennal segments, indicates a relationship with Cystiphora Kieff., from which the genus can be easily separated by the absence of a terminal spine on the short ovipositor. Type *A. juniperi* n. sp.

Allomyia juniperi n. sp. The one female issued June 12, 1918, from a package of apical, burr-like galls on Juniperus received June 5, 1918 from Ivan M. Way, Oxford, Colo.

The gall is a small, apical, burr-like deformity with a diameter of 5 mm. It differs from the larger rosette galls in that there are no distinctly reflexed leaves.

Female. Length 1.5 mm. Antennæ extending to the base of the abdomen, sparsely haired, mostly yellowish and reddish, thirteen sessile segments, the fifth with a length two and one-half times its diameter, a subbasal irregular whorl of long, stout setæ and at the basal third and apically low, fine, indistinct circumfili. Terminal segment produced, with a length over three times its diameter, the apex subacute. Palpi; first segment rectangular, the second quadrate, the third narrowly oval, the second and third with a series of stout, spiny processes apically. Mesonotum dark brown, almost black. Scutellum dark reddish brown, margined with dark brown. Postscutellum dark yellowish orange. Abdomen dark brown, the short ovipositor yellowish orange. Wings hyaline, subcosta uniting with the anterior margin near the basal half, the third vein, strongly curved distally, at the apex of the wing, the fifth probably forked. Halteres pale yellowish. Legs mostly pale straw, the distal portion of tibiæ and the tarsi dark reddish. The one claw on the posterior leg of the specimen is unusually stout, strongly curved, unidentate and the pul-

villi is greatly produced, having a length nearly thrice that of the claw and a width greater than the length of the claw. Ovipositor short, the lobes broad, roundly truncate and thickly clothed with short, stout, spiny hairs. Type Cecid. a 2921.

ASPHONDYLIA DONDIÆ n. sp. The male described below was reared from deformed leaves on sea blite, *Suæda* or *Dondia multiflora*, collected by Professor E. Bethel, April, 1918, at Point Fermine, Calif. It is related to *A. vernoniæ* Felt and *A. ceanothi* Felt from which it is most easily separated by color characters and variations in the length of the third antennal and palpal segments.

The gall is a blackish, globose, sessile, leafy deformation with a diameter of 3 mm.

LARVA. Length 1.75 mm. Stout, yellowish orange, head short, broad, antennæ short, broadly triangular, biarticulate, the terminal segment with a length nearly equal to its diameter. Breastbone quadridentate, the anterior portion with a width nearly double the posterior part, skin coarsely shagreened, posterior extremity broadly rounded.

EXUVIUM. Length 3 mm. Moderately stout, reddish brown and with characteristicly developed rows of spines on the dorsum of the abdominal segments.

MALE. Length 3.5 mm. Antennæ nearly as long as the body, sparsely haired, dark brown, fourteen segments, the third with a length five times its diameter. Terminal segment with a length about four times its diameter and tapering slightly to a broadly rounded apex. Palpi, first segment short, broad, the second about one-half longer than the first, the third more slender, fourth nearly as long as the third. Mesonotum dark brown, the submedian lines thickly clothed with long, white hairs. Scutellum yellowish brown with exceptionally long, whitish hairs. Postscutellum reddish orange. Abdomen dark reddish brown, sparsely clothed with yellowish hairs. Wings almost subhyaline, the membrane with a fuscous tinge. Halteres reddish orange, fuscous subapically. Coxæ dark brown, legs mostly dark straw, the tarsi nearly black. Claws rather slender, strongly curved, the pulvilli a little shorter than the claws. Genitalia; basal clasp segment short, stout, terminal clasp segment greatly reduced, almost unidentate, dorsal plate short, broad, broadly and triangularly emarginate, the short lobes partly rounded. Ventral plate short, broadly and roundly emarginate, the lobes acute, both plates thickly setose. Type Cecid. a 2892.

THECODIPLOSIS COCKERELLI n. sp. The gall of this insect, or at least one nearly indistinguishable therefrom, was received from Glen Eyrie, Colorado Springs, Colo., through Professor T. D. A. Cockerell, in December, 1907. Specimens were received from Ivan Way, Oxford, Colo., from which a female was reared in 1918. The species is probably generally distributed in Colorado at least.

The gall is an irregular, kidney-shaped enlargement of the needles of *Pinus edulis*. It has a length of 7 mm., a diameter of 4 mm.; the walls are thick and the needles rudimentary.

FEMALE. Length 1.75 mm. Antennæ extending to the base of the abdomen, sparsely haired, fuscous yellowish, fourteen segments, the fifth with a stem one-fourth the length of the cylindric basal enlargement, which latter has a length two and one-half times its diameter. Terminal segment somewhat reduced, the basal enlarge-

ment with a length twice its diameter and apically a short, knob-like process. Palpi; first segment irregularly oval, stout, the second a little shorter, more slender, the third a little longer than the second, and the fourth slender, more than twice the length of the third. Mesonotum, scutellum and postscutellum yellowish brown. Abdomen yellowish orange. Halteres whitish transparent, legs mostly pale straw, claws of the hind legs at least, long and moderately stout, strongly curved, the pulvilli a little longer than the claws. Ovipositor when extended nearly as long as the body, distinctly chitinized, subaciculate. The distal portion is rather stout, strongly striate and apically with approximate, triangular, finely dentate lobes, each bearing at the distal fourth two diverging spike-like spines. Type Cecid. a 2822.

MYCODIPLOSIS PACKARDI n. sp. The male of this species was reared June 20, 1918, from a white pine (*Pinus strobus*) branch one and one-half inches in diameter infested with *Parharmonia pini* Kell. The exuded masses of pitch were inhabited by midge larvæ, some of which remained in the pitch, transformed therein and produced adults described as *Retinodiplosis albitarsis* n. sp. There were other larvæ which emerged from the pitch mass and formed cocoons either on the twigs or the bottom of the tree and it is apparently from these other larvæ that this species was reared. The habit of deserting the pitch and making cocoons upon the food plant appears to be identical with that described for *Cecidomyia pini-rigidæ* Packard and there is a possibility that the two are identical, though this cannot be determined with the data available.

COCOON. Length 5 mm., diameter 2 mm. Moderately stout, mostly indistinctly rounded, the pointed apex presenting the appearance of a rather short, stout, waxy process.

MALE. Length 3 mm. Antennæ probably nearly as long as the body, rather thickly haired, fuscous yellowish, fourteen segments, the fifth almost trinodose with stems one and one-fourth and twice their lengths respectively. Basal enlargement globose, the distal enlargement, strongly constricted near the middle with a length almost twice its diameter, the loops of the circumfili moderately numerous and with a length greater than the diameter of the enlargement. Terminal segment having the basal portion of the stem with a length one-half greater than its diameter, the distal enlargement so strongly constricted near the basal third as to suggest two partly adherent spheres and apically a short stem bearing a small subglobose appendage. Palpi; first segment quadrate, the second with a length twice the first, the third slender and with a length one-half greater than the second and the fourth as long as the second, slender. Mesonotum dark brown, with moderately thickly haired submedian lines. Scutellum and postscutellum dark brown. Abdomen sparsely haired, dark brown. Wings subhyaline, the membrane thickly clothed with fuscous hairs. Halteres yellowish basally, fuscous apically. Coxæ fuscous yellowish. Legs mostly dark brown. Claws long, slender, rather strongly curved, the anterior unidentate, the pulvilli about one-half the length of the claws. Genitalia; basal clasp segment rather long, stout; terminal clasp segment a little longer than the basal, slender. Dorsal plate short, very deeply and triangularly emarginate, the lobes narrowly triangular and sparsely setose apically. Ventral plate moderately long, broad, deeply and roundly emarginate, the lobes rather broad, narrowly rounded apically and with a stout seta at the tip. Style long, stout, narrowly rounded apically.

This species runs in the key to *M. emarginata* Felt, from which it is easily separated by both colorational and structural characters. It presents a remarkable similarity to Retinodiplosis with which it is evidently associated and upon which it may prey. The two species, under a hand lens, appeared almost indistinguishable, except that the Mycodiplosis was somewhat smaller. The color characters of this midge are partly conjectural. Type Cecid a 2917a. Named in honor or of Doctor A. S. Packard, one of the first American Entomologists to study the gall midge fauna of our pines.

Retinodiplosis albitarsis n. sp. A series of both sexes was reared in June, 1918, from a white pine (*Pinus strobus*) branch one and one-half inches in diameter, infested with *Parharmonia pini* Kell. The exuded masses of pitch were inhabited by midge larvæ which transformed therein and produced large sized, dark colored adults with very constant, striking tarsal markings. The very similar *Mycodiplosis packardi* was also reared, the larva of this latter apparently deserting the pitch masses prior to transforming. This Retinodiplosis has the general structural and color characters of *R. palustris* Felt, from which it is most easily distinguished by the distinct narrow femoral and tibial white annulations and yellowish white distal three tarsal segments of the posterior legs.

Male. Length 3 mm. Antennæ two-thirds the length of the body, fuscous yellowish or dark brown, fourteen segments, the fifth having stems as long and one-half longer than their diameters respectively, the basal enlargement subglobose, the distal enlargement with a length one-fourth greater than its diameter, vasiform. The circumfili with moderately long, rather abundant stout loops. Terminal segment produced, the basal stem with a length twice its diameter, the distal enlargement produced, with a length over twice its diameter and apically with a small conical appendage. Palpi; first segment short, irregular, the second with a length three times its diameter, the third a little longer than the second, the fourth nearly as long as the third and somewhat dilated apically. Mesonotum dark reddish brown, the submedian lines thickly haired. Scutellum dark brown, apically thickly clothed with yellowish scales. Postscutellum reddish brown. Abdomen sparsely haired, deep reddish brown, genitalia fuscous, Wings thickly clothed with short, dark hairs, subfuscous. Halteres yellowish basally, fuscous subapically, whitish apically. Coxæ dark brown, femora basally fuscous yellowish, subapically fuscous, narrowly annulate with white apically. Tibiæ dark brown, narrowly annulate with white apically. Tarsi dark brown except the yellowish white distal three segments of the posterior legs. Claws moderately long, slender, curved, the pulvilli a little shorter than the claws. Genitalia; basal clasp segment moderately long, stout; terminal clasp segment rather short, stout; dorsal plate deeply and triangularly incised, the lobes irregularly triangular and narrowly rounded apically. Ventral plate rather long, moderately broad and tapering to a broadly rounded apex. Style long, stout, broadly rounded apically.

Female. Length 5 mm. Antennæ extending to the third abdominal segment, sparsely haired, fuscous yellowish, the fifth subsessile, cylindrical, with a length two and one-half times its diameter. Terminal segment somewhat produced, tapering to

a narrowly rounded apex. Mesonotum dark brown, with moderately thick submedian lines of short, silvery scales and with the sublateral areas sparsely clothed with somewhat broader scales. Scutellum dark brown, thickly clothed with silvery scales. Postscutellum dark brown. Abdomen sparsely clothed with fuscous hairs, deep red. Halteres yellowish basally, fuscous apically. Ovipositor probably one-half the length of the body, fuscous yellowish, the terminal lobes yellowish orange. Type Cecid. a 2917.

LARVA. Length 4 mm. Moderately long, stout, strongly segmented, with conspicuous tubercles, the extremities tapering, a variable reddish orange. Head small, subconical, the outer walls apparently slightly chitinized and at the posterio-lateral angles chitinous projections with a length twice that of the head. Antennæ slender, conical. Breastbone irregular, expanded and truncate anteriorly. The lateral and posterior spiracles on tubercles, each supported by a black chitinous, cup-shaped structure; those of the anal pair larger and strongly dentate. Abdominal segments, except the eleventh and twelfth, each with a submedian pair of long, fleshy tubercles, the length approximately one-third the body width, most of them more or less furcate. The lateral tubercles support the spiracles and are about one-fourth the length of the subdorsal tubercles. Ventrally pseudopods are fairly well developed on the tenth, eleventh and twelfth segments, those on the last spine tipped and apparently with the same structure as the subdorsal tubercles.

ONODIPLOSIS SARCOBATI Felt.[1] The male described below for the first time was received May 20, 1918, from Professor Harold R. Hagan, Logan, Utah, and a series of both sexes were reared from bud galls on *Sarcobatus vermiculatus*, the adults issuing directly from the gall after the pupa had worked itself about three-quarters out of the deformity.

MALE. Length 2.5 mm. Antennæ a little longer than the body, sparsely haired, pale yellowish, fourteen segments, the third and fourth free, the fifth having stems each with a length about twice its diameter; the basal enlargement subglobose with a sparse subbasal whorl of stout setæ and a circumfilum with moderately short loops; the distal enlargement pyriform, with a length one-half greater than its diameter; a subbasal and subapical circumfilum, each with loops having a length less than the diameter of the enlargement; terminal segment, basal enlargement subglobose, basal portion of the stem produced, slender, the distal enlargement irregular and tapering to an obtuse apex. Palpus consisting of an irregular, tapering setose segment with a length about twice its diameter. Mesonotum dark yellowish brown. Scutellum and postscutellum very dark brown, almost black. Abdomen sparsely haired, fuscous yellowish, genitalia somewhat darker. Wings as in the female. Halteres whitish basally, fuscous yellowish apically. Coxæ dark brown, legs mostly pale straw. Genitalia; basal clasp segment stout, with a length about twice its diameter, terminal clasp segment moderately long, swollen subapically, the chitinous tip pectinate. Dorsal plate long, deeply and triangularly emarginate, the lobes broad, broadly rounded, ventral plate short, broadly emarginate, lobes broadly rounded. Harpes widely separated apically, roundly tapering and sparsely setose. Style short, chitinized apically. Cecid. a 2914.

PUPA. Length 2.5 mm. Head, thorax, antennæ, wing and leg cases all a somewhat variable fuscous yellowish. Abdomen red, smooth.

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[1] 1916, Felt, E. P., N. Y. Ent. Soc. Journ., 24: 176.

A NEW CORN INSECT FROM CALIFORNIA (HETEROPTERA)

By CARL J. DRAKE, *New York College of Forestry*

Several weeks ago I received a number of "lace-bugs" or Tingidæ that had been collected upon corn or maize, *Zea mays*, in Grass Valley, California, by Professor Essig. A careful study of this material indicates the species to be an undescribed species belonging to the genus *Corythucha*. Corn is undoubtedly the food plant of this tingid as Professor Essig collected nymphs as well as adults on it and noted the injury to the leaves caused by the feeding of both nymphs and adults.

CORYTHUCHA ESSIGI sp. new. Hood moderately large, abruptly constricted just back of the middle, the length about three times its greatest height, the posterior portion low and highest at the constriction. Paranota moderately broad, reniform, the margins, except anterior ones, destitute of spines. Pronotum punctate; median carina rather low, very slightly rounded at the middle, with a single row of large areolæ, a little longer than the length of the base of the entire hood; lateral carinæ widely separated from the hood, with four or five distinct areolæ. Legs moderately slender. Rostral laminæ with large cells, the rostrum extending between the intermediate coxæ. Elytra rather narrow, the outer margins slightly concave and unarmed or spineless; costal area triseriate or nearly triseriate, the areolæ irregular in size. Wings extending slightly beyond the apex of the abdomen. Claspers strongly curved in the male. Length, 2.8 mm.; width, 1.5 mm.

Color: General color whitish, with a few fuscous markings on the nervures. Nervures of the hood, paranota, and carinæ whitish, except a few nervelets on the hood and paranota fuscous; areolæ hyaline. Elytra whitish, with a transverse band near the base (areolæ very slightly dusky) and a more or less oblique band (areolæ slightly dusky or hyaline) near the apex fuscous; areolæ hyaline. Legs yellowish white, the tips of tarsi dark brown. Body beneath black.

Several specimens, taken in Grass Valley, California, September 7, 1917. This seems to be the first record of a species of Tingidæ that infests corn. *Corythucha distincta* O. & D., has been taken in Montana (Cooley) upon corn, lettuce, parsnip, beans, lupine, turnip, squash and *Balsamorrhiza* and in Utah (Larson) upon *Carduus lanceolatus*. *Distincta* is a very variable species in color, but it is readily separated from *essigi* by its much higher hood, larger size, etc. *Essigi* is probably most closely allied to *obliqua* O. &. D. from which it can be readily distinguished by the color pattern, the shape of the hood and median carina. *Obliqua* feeds upon *Ceanothus* and is a very common form along the Pacific slope.

Type in my collection; *paratypes* in collections of Professor Essig and the author.

Scientific Notes

Apple tent caterpillar parasites. Two parasitic cocoons were taken from a nest at Corinth, N. Y., June 23, 1915. The cocoons are about a quarter of an inch long, subcylindrical with rounded extremities, chalky white with black markings as illustrated in figures 7 and 16 on pages 20 and 33 respectively of Technical Series No. 5, Division of Entomology, United States Department of Agriculture. The cocoon is, with very little question, that of *Amorphota orgyiæ* How., while the parasite which was reared from the cocoon proved to be *Otacustes periliti* Ashm. Both of these species have been earlier recorded as parasites of the white marked tussock moth, *Hemerocampa leucostigma* Sm. and Abb. in the above cited Bulletin.

E. P. Felt.

A Chigger Mite of Chrysopa Larvae. In December, 1917, Mr. Rodger C. Smith, of Milwaukee, Wisconsin, sent us three specimens of larvæ of *Chrysopa rufilabris* to which were attached four larvæ of the Erythræidæ belonging to the genus Erythræus. These specimens were taken August 25, 1917, near the Soldiers' Home, Milwaukee, Wisconsin. Mr. Smith states that they were of a bright red color before being put in alcohol.

This is the first record to our knowledge of a specific parasitic mite of Chrysopa larvæ. The shape of the cephalic shield and the arrangement of the coxal setæ are quite different from that of the larvæ of any American species of this genus. As the adult of this form is not known we hesitate to describe it as new.

Albert Hartzell, *Iowa State College, Ames, Iowa.*

Anthracophaga distichliæ sp. n. Male and female. Pale yellow, subopaque, marked with grayish black on disk of thorax, and brownish black on abdomen and legs. Ocelli surrounded by a black spot; triangle with a dark brown streak from posterior lateral angle to or a little beyond the middle on each side, and a central stripe from anterior extremity to midway to anterior ocellus; third antennal joint black; arista fuscous at base, yellowish beyond; palpi fuscous, pale basally. Thoracic dorsum with five opaque black vittæ in fresh specimens, the lateral pairs abbreviated anteriorly; a very distinct pale oval spot on middle of lateral margin above and between the notopleural bristles; humerus with upper half black; anterior spiracle glossy black; sternopleura, mesopleura, pteropleura, hypopleura and metanotum largely black; scutellum with a large black spot on each side. Dorsum of abdomen black-brown, each segment with a narrow yellow posterior margin, which projects in the form of a short wedge anteriorly at middle. Legs variable in color, usually with femora and hind tibiæ brownish on middle. Wings grayish, veins brown, slightly clouded. Halteres white.

Frons over half the head-width; triangle very large, occupying nearly the whole width of vertex, and extending to anterior margin, the sides convex; entire frons including triangle, with short, black, setulose hairs; face in profile slightly concave, retreating below; antennæ small, third joint as broad as long, slightly angulate on upper side at apex; arista tapered, with microscopic pubescence; eyes about 1.5 as high as long; cheek rugose, coarsely so posteriorly, half as high as eyes, with numerous short, black hairs; thoracic dorsum with short, setulose, decumbent hairs; mesopleura with a few weak setulose hairs posteriorly; scutellum with six marginal bristles and numerous discal hairs. Abdomen with hairs like those of thorax. Legs normal,

stout. First costal division slightly longer than second, the latter nearly twice long as third; last section of fourth vein about five times as long as preceding section.

Length, 3.5–4 mm.

Type locality, Long Beach, Cal., July 7, 1916, reared in the New York State Museum from a bract-covered gall on *Distichlis apicata* collected by Prof. E. Bethel.

This species is allied to *declinata* Becker but that species differs essentially in color and structure of head.

J. R. Malloch.

Codling Moth Activities at Time of Total Eclipse. The writer observed the activities of the codling moth during the period of the sun's eclipse, June 8, 1918, at Hood River, Oregon. The notes were taken in the Experiment Station orchard. This particular insect is quiet during the daytime, engaging itself in mating and egg laying at twilight and continuing on into the night if temperatures are sufficiently high. The effect of this unnatural darkness upon the insects was therefore watched with interest.

At Hood River totality was reached at 4 o'clock. At 3.47 light became sufficiently subdued to cause the insects to take wing. They immediately began to seek out favorable locations upon which to deposit eggs and an insect was observed depositing an egg at 3.50. This was followed by the deposition of two others shortly thereafter, following which it became too dark to observe further activities and this particular moth was lost sight of. Moths were noted on the wing until 4.15 after which it apparently became so light that the inclination for further egg laying left them. Egg laying was noted as taking place normally at 8 o'clock in the evening of this date.

The temperature during the half hour between 3.45 and 4.15 dropped exactly 10° F., or from 86° F. to 76° F.

The rapidly diminishing light and temperature had a very decided influence upon all insect life. The day was particularly favorable for general insect activities, being both quiet and warm, with many flowers in bloom. Many species of bees and flower flies were on the wing and the hum of the insects in their flights was distinctly audible. As darkness approached the flights of the insects almost instantly ceased and with it the hum of their busy wings. The death-like quiet which followed for a few moments due to this added further to the strangeness of the scene. Several species of bees, Syrphids and Tipulids were noted at rest on apple foliage as the sun's light began to establish itself.

Leroy Childs,
Entomologist and Plant Pathologist, Hood River Experiment Station.

Culicidæ of Colorado. Through the kindness of Prof. C. P. Gillette, we have been permitted to examine the Culicidæ in the collection of the State Agricultural College. The specimens do not bear the names of collectors, but most, at least, appear to have been obtained by Mr. G. P. Weldon. There is one species new to the state; *Aedes cinereus* Mg., three from Estes Park, July 11, 1912. One of these had already been determined by Mr. Knab. The *Anopheles quadrimaculatus* from Hotchkiss appear to have the pale bands on thorax better defined than in eastern specimens, and more material may indicate a subspecies. The following are new records from localities from which we already had some material:

Delta. *Aedes curriei*, 20 ♀, *A. vexans* 1 ♀, all July 18, 1911.

Estes Park. *Aedes samsoni*, 9 ♀, July 11 and 16. Also 18 ♀ apparently *A. pullatus*, but none perfect.

Grand Junction. *Aedes nigromaculis*, 22 ♀, July 12 and 27; *A. curriei*, 18 ♀, July 12, 13, Aug. 10; *A. vexans*, 14 ♀, May 24, July 14, Aug. 30. It appears that

vexans comes on early and late in the season, with the maximum of the other two species between.

HOTCHKISS. *Culex tarsalis*, Aug. 29.

The following localities are new:

ARKINS (Larimer Co., 5,224 ft.). *Aedes vexans*, Aug. 3.

FORT COLLINS (Larimer Co., 4,984 ft.). *A. nigromaculis*, June 13, 18, Aug. 14; *A. curriei*, small females, Aug. 17; female with dark markings of abdomen lacking, May 31.

GUNNISON (Gunnison Co., 7,673 ft.). *A. curriei*, bad condition but apparently this, June 25; *A. aldrichi*, several, June 25. The latter are not in very good condition, but agree with *aldrichi;* one had already been determined by Knab.

LOVELAND. *Aedes* sp. too poor.

MONTE VISTA (Rio Grande Co., 7,653 ft.). *A. curriei*, 7 very poor specimens, Aug. 20.

PALISADE (Mesa Co., 4,729 ft.). *A. curriei* and *A. vexans*, Aug. 11.

STERLING (Logan Co., 3,932 ft.). 14 *A. curriei* and 3 *A. nigromaculis*, July 31.

T. D. A. COCKERELL and JOHN T. SCOTT.

Notes on Eleodes tricostata Say. After the publication of the most able article on *Eleodes tricostata* Say, by James W. McColloch, in the April issue of this magazine, the following notes may be of interest. Early in March, complaints came to this office concerning a new cutworm. Investigation showed this to be the larva of *Eleodes tricostata*. These complaints increased up to April 25 and since have gradually decreased. With a few exceptions, every county from Wilbarger on the north to Jim Wells on the south, and from Callahan east to the state line, report the presence of this worm in destructive numbers. In fact, more complaints were made in March, April and May about this insect than all others combined. The work of the larva somewhat resembles that of the true cutworms, but the larva will also climb large plants and cut off buds and leaf stalks. It works very heavily on radishes, cabbage, onions, tomatoes, potatoes, corn, cane and almost everything else in garden or field.

Most gardeners were satisfied with the results obtained from the use of poisoned bran mash, Paris Green giving better results than arsenate of lead. The adults are extremely plentiful this year. They may be found in old or heavily pastured fields, where from two to a dozen or more will be found under each pile of dry manure. This has given many gardeners the notion that this cutworm was brought into the garden with barnyard manure. The adults have a very peculiar habit of sunning themselves on ant hills during the warm days of winter. There must be some vital connection between this beetle and the agricultural ant, as adult Eleodes are more abundant near the ant hills than elsewhere. The larva works at night and on cloudy days. Because of its voracious appetite and omnivorous habits, it has been dubbed the Kaiser worm by the war gardeners of central Texas.

H. B. PARKS,
Extension Entomologist, A. and M. College, College Station, Texas.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1918

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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Two of our comrades have passed on. They have made the supreme sacrifice gladly. Their example urges us to greater effort. They realized that the better part of life is service. Let us render them all possible honor and join in grateful recognition of their efforts. Young in years, strong of heart, undaunted in spirit, they gave their all. None can do more. We sorrow at the parting and rejoice that so noble a cause should have taken them from us. May each of us heed the call of duty in an equally devoted spirit.

Entomologists are not primarily soldiers and yet the practise of their calling, the successful control of insects, may have a most vital effect upon military success. A striking case is the Macedonian campaign and the pernicious type of malaria prevailing in connection therewith. Preventive doses of quinine apparently failed, malignant tertian malaria prevailed and hemoglobinuria was frequent.

The following significant figures are from the British Medical Journal of March 23, 1918. In the British Army in one region during January about one man in 1,000 was evacuated weekly to the base with malaria. The number then rose steadily until in the third week of May about one in 130 (about 7.6 in 1,000) had to be evacuated. From July until into September, the rate was 1 in 55 (about 18 in 1,000). There was a rise in mid-September and the maximum for the year was reached the second week of October when the rate was 33 in 1,000. Some specially exposed units had almost if not absolutely all their personnel infected at the same time and in a few cases as much as one-third of the strength of the unit had been evacuated to the hospital within a month during the height of the malarial season. These figures are for 1917 and represent conditions after continuous anti-malarial work that resulted in a considerable lessening of the number of cases as compared with the previous year.

Obituary

JOHN W. BRADLEY

Lieutenant John W. Bradley of the Aviation Branch of the United States Army, met with an accident July 2nd at Wilbur Wright Field, Dayton, Ohio, which resulted in his death two days later. Lieutenant Bradley was a graduate of the Massachusetts Agricultural College and had been employed several years as a Scientific Assistant in the Bureau of Entomology, and worked at the Gipsy Moth Laboratory, Melrose Highlands, Mass. He enlisted as a Cadet in November, 1917, received ground training at the Massachusetts Institute of Technology and Princeton University, after which he was ordered to Wilbur Wright Field for instruction in flying. He completed this course and received his commission as Lieutenant about a month ago, and after a few days furlough was appointed instructor. The accident happened while Lieutenant Bradley was flying with a Cadet. The machine fell about 150 feet. The injuries which he sustained were so serious that he died two days later.

A. F. B.

VERNON KING

With deep regret attention is called to the death of Lieutenant Vernon King, formerly Scientific Assistant in the branch of Cereal and Forage Insect Investigations, Bureau of Entomology, United States Department of Agriculture. Lieutenant King was at one time attached to the staff of the Wellington, Kans., field laboratory and was afterward placed in charge of the station at Charleston, Mo. He resigned from the service November 5, 1914, for the purpose of entering the British Army, and proceeded to Canada with this idea in view. For some reason he was not admitted to the Canadian troops and went to England where he gained an appointment in the service for sea duty. For some time he was stationed at the Dardanelles but more recently had become a member of the flying corps and the last direct news received from him stated that he was flying in the vicinity of Verdun. The press account of his death, which is in the form of a letter from his Commanding Officer, Maj. C. F. A. Portal, addressed to Lieutenant King's father, states that while serving as a flying observer on April 11, 5.20 p. m., his plane was attacked by three enemy scouts and shot down. Lieutenant King lived for about one-half an hour but did not regain consciousness. During Mr. King's term of service in the Bureau of Entomology he made many friends by reason of his genial personality and vivacious disposition. The chief investigations

conducted by him were those on the corn wireworm, *Horistonotus uhleri*, afterwards completed by Mr. E. H. Gibson under the direction of Mr. W. R. Walton, Entomologist in Charge, Cereal and Forage Insect Investigations.

The following is a copy of the letter of Major Portal:

No. 16 Eqn. R. A. F., B. E. F.
April 12th.

Dear Mr. King:

I am extremely sorry to have to tell you that your son, Lieut. V. King, was killed in action in an air fight yesterday, April 11, at 5.20 p. m.

He was flying as an observer to Captain Jones, the most experienced pilot in the Squadron and they were attacked and shot down by three enemy scouts. Your son put up a great fight, firing 250 rounds at the hostile machines, but they could not cope with odds of three to one for long, and were eventually shot down. Your son lived for about one-half hour, but never regained consciousness.

We are extremely sorry to lose him, as he was very popular with all ranks of the Squadron. Always keen and cheerful, he set a splendid example to everyone, and did much to keep up the high spirits which this unit has always shown.

We brought his body in last night and he will be buried by the side of his pilot and many other brave men from this Squadron at Aubigny, near here, on the road from Arras to St. Pol.

Please accept on behalf of the whole Squadron our deepest sympathy in your sad loss.

Yours very sincerely,
(signed) C. F. A. Portal (Major),
35 Whitehill Road, Graves Ent.

Current Notes

Mr. A. K. Pettit of the Dallas, Texas, laboratory of the Bureau of Entomology has enlisted in the Coast Artillery.

Mr. Ottomar Reinecke, who has published lists of Coleoptera, of Buffalo, N. Y., died November 26, 1917, aged seventy-seven years.

Mr. E. H. Gibson of the Bureau of Entomology has been commissioned a lieutenant in the Sanitary Corps of the United States Army.

According to *Science*, Dr. W. D. Funkhouser (Cornell) has been appointed head of the department of zoölogy at the University of Kentucky.

The degree of Doctor of Laws (LL.D.) was conferred upon Surgeon-General William C. Gorgas by New York University at its recent commencement.

Mr. A. C. Lewis has been appointed state entomologist of Georgia in place of E. L. Worsham, whose resignation was announced some time ago.

Professor John H. Comstock of Cornell University lectured before the Syracuse Chapter of Sigma Xi, April 1, on the Habits of Spiders.

Professor H. T. Fernald of the Massachusetts Agricultural College has returned to Amherst after a six months' leave of absence spent in the Southwest.

Mr. J. E. Eckert has been appointed assistant entomologist in field work and nursery inspector in the Station, vice S. C. Clapp, at the North Carolina Station.

Dr. F. W. Pettey of Cornell University, has resumed his duties as entomologist for Cape Province, South Africa. His address is Elsenberg Agricultural College, Mulders Vlei, Cape Province, South Africa.

George S. Demuth and E. F. Atwater of the Bureau of Entomology, held a series of meetings in California in the spring, the subject being the control of European foul brood.

Professor George G. Becker, state entomologist of Arkansas, has resigned his position to enter the military service of his country. His address for the present is 502 North Calhoun St., Baltimore, Md.

Mr. Charles E. Sleight of Paterson, N. J., a collector of insects, and member of the New York and Brooklyn Entomological Societies, died at Ramsay, N. J., May 20, 1917, aged fifty-seven years.

Professor A. C. Burrill, formerly state entomologist of Idaho, has been appointed special field agent, Bureau of Entomology, to assist in extension work on cereal and forage insect control in Washington and Oregon.

Dr. Paul S. Welch, Kansas Agricultural College, is a member of the zoölogical staff of the Biological Station of the University of Michigan at Douglas Lake; the tenth session extends from July 1st to August 23d.

Dr. E. P. Felt delivered an illustrated lecture on "Garden Insects — good and bad—" May 19th at the Brooklyn Botanic Garden, this being one of a series of "Win-the-War-Gardens" lectures inaugurated for Sunday afternoons at four o'clock.

Professor C. L. Metcalf, professor of Economic Entomology at the Ohio State University, Columbus, Ohio, is spending the summer in Ithaca, N. Y., where he has charge of the course in general biology in the summer session of Cornell University.

Mr. W. H. Goodwin of the laboratory of Economic Zoölogy, Harrisburg, Pa., has accepted a position with the state entomologist of New Jersey and is in charge of eradicating the Japanese beetle, *Popilia japonica* Newman, an infestation of which was discovered last year at Rutherford, N. J.

Mr. Reyne, who is on his way from Holland to take a position as government entomologist in Dutch Guiana, spent about a month in the United States in June and July visiting the Bureau of Entomology and the Agricultural Experiment Stations at College Park, Md., New Brunswick, N. J., and New Haven, Conn.

According to *Entomological News*, the deaths of the following European entomologists are announced: Dr. Emile Frey-Gessner, Geneva, Switzerland (particulars not given); William Henry Harwood, English Lepidopterist and Hymenopterist, born

February 25, 1840, died December 24, 1917; Richard S. Standen, English Lepidopterist and artist, born October 11, 1835, died July 29, 1917.

Mr. Irving W. Davis, for five years assistant to the state entomologist and deputy in charge of gipsy moth work in Connecticut, has been granted a leave of absence, dating from July 1, 1918, to enlist in the Marine Corps. During his absence the field work will be in charge of Mr. John T. Ashworth.

A hearing was held on May 28, before the Federal Horticultural Board at Washington, D. C., relative to restricting or prohibiting the importation of nursery stock from foreign countries. Some entomologists present were: F. C. Lewis, Georgia; Franklin Sherman, Jr., North Carolina; W. J. Schoene, Virginia; J. G. Sanders, Pennsylvania; T. J. Headlee, New Jersey; W. E. Britton, Connecticut, and A. G. Ruggles, Minnesota.

A meeting of the Massachusetts Tree Wardens' Association was held July 11 and 12, several points in Massachusetts being visited. Some entomologists present were J. M. Swaine and J. B. McLaine of Canada; Professor G. W. Herrick, Cornell University, Ithaca, N. Y.; W. E. Britton, state entomologist, New Haven, Conn.; A. F. Burgess, L. H. Worthley, D. M. Rogers and C. W. Collins of the Bureau of Entomology.

The New York Entomological Society celebrated its twenty-fifth anniversary, June 7, 1918, by holding a special meeting at the Hotel Colonial, 81st Street and Columbus Ave., New York City. The program included a history of the Society, reminiscences by Mrs. Annie Trumbull Slosson, Mr. Henry Bird and others, and remarks by guests representing sister societies, among whom were Dr. Henry Skinner and Mr. J. A. G. Rehn of the American Entomological Society of Philadelphia.

Dr. Carlos Moreira of Rio de Janeiro, Brazil, chief of the Bureau of Agriculture of the National Museum, and commissioner of the Department of Agriculture of Brazil, visited the Bureau of Entomology for two or three days during March. Dr. Moreira was in this country as a special commissioner with many assignments. He was able to spend only a very small part of his time with the entomological force of the bureau.

The following resignations from the Bureau of Entomology are announced: J. S. Stanford, fruit insect extension work, Idaho; C. W. Cartwright, assistant, Knoxville, Tenn., to enter the army; C. E. Bartholomew, apiculture; G. C. Mathews to return to commercial beekeeping in Idaho; C. P. Trotter, Mound, La., to enter the Naval Hospital Service; Scott Johnson, cereal and forage insect extension work, Kansas, to enter the navy; H. N. Gellert, truck crop insect extension work, Florida; S. W. Frost, truck crop insect extension work, New York, to accept a position with the Pennsylvania State College; P. B. Miles, alfalfa weevil investigations, Salt Lake City, Utah.

Mr. A. E. V. Richardson, of the Department of Agriculture at Victoria, Australia, visited the Bureau of Entomology on May 20th. He is looking into the bureau organization of the United States Department of Agriculture and the general subject of agricultural organization and coöperation in the United States, with extreme care. The Federation of Australian States is investigating the desirability of bringing about a federal agricultural service, and all of the problems connected with such an organization are under careful investigation. The different colonies in Australia have developed strong departments of agriculture with an entomological service in each one. The old problem of "States' Rights" is naturally more confusing out

there with the new federation than it is in the United States or even in South Africa. In the latter case there has been not simply a federation, but a much more centralized organization.

Announcement has been made of transfers in the Bureau of Entomology as follows: W. H. Foster, Washington, to Oregon; A. J. Ackerman, Benton Harbor, Mich., to Bentonville, Ark.; J. J. Culver, Monticello, Fla., to Fort Valley, Ga.; H. G. Ingerson, Sandusky, to Cleveland, Ohio; R. B. McKeown, Brownwood, Tex., to Medford, Ore.; H. K. Plant to Seaview, Wash., in charge of laboratory for investigation of cranberry insects; Marion R. Smith, Baton Rouge, La., to Plymouth, Ind.; O. K. Courtney, Gainesville, to Glen St. Mary, Fla.; Thomas H. Jones, Baton Rouge to New Orleans, La.; Frank R. Cole, truck crop insects to cereal and forage insect investigations, Northwestern States; F. B. Milliken, New Orleans, La., to Amarillo, Tex.; G. H. Gale, Washington, D. C., to apicultural extension work, Wisconsin; A. L. Ford, Wellington, Kans., research laboratory, to cereal and forage insect extension work, Kansas; D. C. Parman, extension work on insects affecting domestic animals, Texas to Louisiana; R. H. Hutchinson, investigations of the body and head louse, New Orleans, La.; J. U. Gilmore, tobacco insects, South Boston, Va.; F. L. Chamberlain, tobacco bud worm, Quincy, Fla.

Appointments to the Bureau of Entomology are reported as follows: R. W. Kelly, Ohio State University, special field agent, fruit insects, Lafayette, Ind.; A. B. Black, Oregon Agricultural College, special field insects, Corvallis, Ore.; Charles A. Weigel, New Hampshire College, Federal Horticultual Board; Miss Emily S. Reed, Cornell University, scientific assistant, tropical and subtropical insects; E. G. Baldwin, apicultural extension work in Indiana, Ohio and Michigan; Felix Dabadie, truck crop insects, Louisiana; Max W. Reeher, special field agent, cereal and forage insect extension work, Pacific Northwest; B. G. Thompson, cereal and forage insect extension work, Oregon and Washington; George H. Rea, special field agent, apicultural extension work, New York; D. A. Davis, apicultural extension work, Iowa; William A. Hoffman, Cornell University, scientific assistant, insecticides; Leo C. Antles, Colorado Agricultural College, scientific assistant codling moth experiments, Grand Junction, Col.; Dr. Oscar H. Basseches, United States College of Veterinary Medicine, scientific indexer; Eugene L. Prizer, University of California, special field agent, citrus insects, California and Arizona; Charles Batchelder, truck crop insect, extension work, Maine; Perry W. Fattig, special field agent, cereal and forage insect extension work, North Dakota; C. K. Fisher, special field agent, cereal and forage insect extension work, Colorado; H. R. Painter, cereal and forage insect investigations, Charleston, Mo.; L. G. Gentner, truck crop insect, extension work, Wisconsin; J. G. Griffith, cereal and forage insect extension work, New Mexico; Marshall Hertig, cereal and forage insect extension work, Minnesota; G. J. Hucker, cereal and forage insect extension work, Nebraska; H. E. Jaques, cereal and forage insect extension work, Iowa; Clay Lyle, truck crop insect extension work, Mississippi; A. D. Tilton, fruit insect extension work, Massachusetts; Roger Smith, corn ear worm investigations, Charlottesville, Va.; A. H. Hollinger, Columbia, Mo., cereal and forage insect investigations, College Station, Tex.; E. O. G. Kelly, extension entomologist, Kansas; scouting for Oriental peach moth—E. D. Brown, William M. Robinson, R. P. Allaman, J. H. Smith, V. A. Roberts, E. T. Rannells, H. B. Pierson, H. S. Saidel, C. H. Alden, J. H. Boyd, and A. F. Vierheller.

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SPRINKLING SEWAGE FILTER FLY

PSYCHODA ALTERNATA SAY

By Thomas J. Headlee, Ph. D. and Charles S. Beckwith, B. Sc.

Introduction

This small light-colored moth-like fly has proven itself a serious nuisance wherever sprinkling filters have been utilized for the purification of fæcal sewage. When the sprinkling filters are located at great distances from human habitation the matter seems to have proven a nuisance only; but when located within reach of human habitation three-fourths of a mile or less, these flies penetrate the houses, get into the foods and are accused by the persons concerned as being the carriers of infections from which they suffer. There seems to be no clear-cut evidence to show that they are responsible for the carriage of infections, but in the opinion of the part of the public concerned they are firmly identified as carriers, and suits at law have been and are always likely to be filed against the municipality or company running such a filter plant.

The Joint Sewer Committee of the City of Plainfield and the Boroughs of North Plainfield and Dunellen, feeling that everything possible should be done to render the sewage disposal plant under its charge a pleasant neighbor for the people living in the vicinity, called the senior author into consultation for the purpose of finding out a way to eliminate this nuisance. A survey of the literature showed that the only method holding out any hope of controlling the pest was one embodied by Metcalf and Eddie in their advice to use charges of hypochlorite of lime.

After considerable reflection, the senior author decided that a study of the insect and its habits would have to be made and a test of the various insecticides instituted.

Habits and Life-History

The work began when the sprinkling filter still had a capping of ice. It was found that each piece of stone had upon it a more or less complete amorphous coating, which on examination proved to be exceedingly complex, being composed of a groundwork or matrix of gelatinous material in which and on which were found immense numbers of bacteria, algæ, protozoa (single celled animals), worms (unsegmented and segmented) and arthropods, principally crustacea and insects. The sprinkling sewage filter fly was found in the maggot and pupa stages resting in this film with the breathing tube or tubes projecting through the film and securing atmospheric air.

As soon as possible the junior author undertook the task of determining the life-history and habits. This study continued through the spring into the summer. It was found that the principal species concerned was *Psychoda alternata* Say, but that during the latter part of April *Psychoda cinerea* Banks appeared. It was found that with the opening of warm weather, the flies emerged from the over-wintering pupæ and larvæ in such numbers that for a period it was almost impossible to breathe while working at the filter without getting some of them in the nose and mouth. After the over-wintering film had broken down and sluffed off and the warm weather film had begun to form, the flies rapidly disappeared until they became so scarce as no longer to form a nuisance. Records of the preceding summer (1917) show that with the advancement of the season the summer film becomes heavier and the flies more abundant until in the month of August, when they reach a density greater even than that of the fore part of the warm season.

It seems that the abundance of flies is correlated with the thickness of the film. A thick heavy film is normally accompanied by a tremendous breeding of the sprinkling sewage filter fly.

A study of the food habits of the maggots showed that the feeding takes place in the film and that the food apparently consists of portions of the film. This habit of feeding, of course, serves to explain the increase in fly breeding which accompanies an increase in the thickness of the film.

The eggs are laid upon the surface of the stone in irregular masses of from 30 to 100. The egg is about .36 mm. long and .17 mm. wide, oval in shape, white in color and resembles under a microscope nothing so much as a very small rice grain. With the exception of the yolk,

the egg is almost transparent. From 32 to 48 hours were required for hatching at a temperature of 70° F.

The larvæ or maggots are very much like mosquito wrigglers, and seem to pass their existence in much the same way. Soon after hatching they make their way into the film where they thrust their breathing tubes through the film itself. The number of larvæ on a sprinkling sewage filter bed is almost unbelievably large. A single square inch of stone has been found to accommodate as many as sixty specimens. The larvæ are present throughout the filter from top to bottom, but they are most abundant in the zone which begins three inches below the surface and ends twelve inches below the surface. The length of the larval stage ranges from nine to fifteen days under a temperature of 70° F. The largest active larva taken at any time in this study was 9.2 mm. long.

Transformation to the pupa takes place in the location where the larvæ fed and developed. The pupa, of course, does no feeding and is able to move only by jerking its abdomen. The pupa is about 6 mm. long, exclusive of the breathing tubes, and requires from 20 to 48 hours to complete development at 70° F.

Control

The habits of the adult fly are such as to preclude the control of the species through the destruction of the mature form. Nothing short of covering the filter with screening which has been treated with a substance similar to tanglefoot could be depended upon to destroy the adult. The shutting off of the air supply, which would result from covering the filters in this way was thought by the engineer in charge to be undesirable from the standpoint of the effective operation of the filter. Furthermore, the cost of such an installation would be large and the length of time the netting would remain effective would be limited.

The problem of control seemed therefore to narrow down to a question of destroying the fly in its immature stages. In view of the fact that the immature stages of the fly, with the exception of the egg, are passed in the film, which is the active agent in the purification of the sewage, it seemed necessary to secure an agent, which would be selective in its action in destroying the immature stages of the fly and not seriously injuring the other components of the film. A considerable number of chemicals was tried in all cases with a view of determining the minimum dosage for the fly and its effect on the life and activity of the other elements of the film. The tables which follow will serve to show the results.

Table of Insecticides I

	Borax	Hypochlorite of Lime	Stone Lime	Copper Sulphate	Iron Sulphate	Pyrethrum
1/2 in. coating	Larvæ dead Film dead	Larvæ dead Film dead	Larvæ dead Film dead	Larvæ dead Film dead	Larvæ dead Film dead	Larvæ dead Film dead
1/4 in. coating	Larvæ dead	Larvæ dead	Larvæ dead	Larvæ dead	Larvæ dead	Larvæ dead
1/8 in. coating	Larvæ dead Film dead	Larvæ dead Film dead	Larvæ dead	Larvæ dead	Larvæ dead	Larvaæ dead Film dead
1/16 in. coating	Larvæ dead Film dead	Larvæ dead Film dead	Larvæ dead	Larvaæ dead	Larvæ dead	Larvæ alive Film alive
1/32 in. coating		Larvæ dead Film dead	Larvæ dead Film dead	Larvæ dead Film dead	Larvæ dead Film dead	
1/64 in. coating		Larvæ dead Film dead	Larvæ dead Film dead	Larvæ dead Film dead	Larvæ dead Film dead	
1/128 in. coating		Larvæ dead Film dead	Larvæ alive Film alive	Larvæ dead Film dead	Larvæ alive Film alive	
1/256 in. coating		Larvæ dead Film dead		Larvæ dead Film dead		
1/512 in. coating		Larvæ dead Film dead		Larvæ alive Film alive		
1/1024 in. coating		Larvæ dead Film alive		Larvæ alive Film alive		

Table of Insecticides II

	Carbon Bisulphide	Black Leaf 40 Diluted 1–50	Black Leaf 40 Diluted 1–500	Saturated Solution of Hellebore
1 oz. to sq. foot	Larvæ dead Film dead	Larvæ dead Film alive	Larvæ alive Film alive	Larvæ dead Film dead
1/2 oz. to sq. foot	Larvæ dead Film dead	Larvæ dead Film alive	Larvæ alive Film alive	Large Larvæ dead Small Larvæ alive Film active
1/4 oz. to sq. foot	Larvæ dead Film injured but still alive	Larvæ dead Film alive	Larvæ alive Film alive	

In general the tables show that the minimum dosage for the fly is destructive to the film. Three materials, 40 per cent nicotine, carbon bisulphide and hypochlorite of lime gave some promise but the first two were eliminated by reason of their cost. Hypochlorite of lime having been indicated by these tests as a possible agent, and having been advocated by Messrs. Metcalf and Eddy on page 760, Volume III of the American Sewage Practice, the writer desired to give it a test on the bed.

Twelve pounds of hypochlorite of lime were applied at the Plainfield plant through the dosing tanks on one day, and the second day thereafter the dose was repeated. About 60 per cent of the larvæ disappeared. It seemed as if the first day's dosage killed or removed a part of the film and that the third day's dosage killed a large part of the larvæ. The incomplete kill resulting from this first treatment led to

a trial of increased strength. Similar tests were made with 15, 30 and 50 pounds per acre. The kill being still incomplete, the 50 pounds per acre treatment was repeated three days in succession and gave a kill of about 85 per cent of the maggots. Many of the maggots appeared in the final tanks alive and fully 15 per cent remained in the filter bed unharmed. The film was considerably injured by the heavier treatments, particularly the last one.

Thus it is seen that the tests of chemical substances brought forward nothing of a satisfactory nature for the control of the sprinkling sewage filter fly.

Flooding

The senior author early in the study brought into the laboratory some of the filter stones and, desiring to keep the material on them alive until the following day, covered them with tap water. When he undertook to resume examination of the film on the following day, he found that all of the maggots of the sewage filter fly were dead. This accidental observation, when correlated with the fact that the breathing tubes of the maggots and the pupæ projected through the film in such a way as to enable the creatures to obtain atmospheric air, led promptly to the suspicion that the species could be destroyed by drowning.

Examination of the film for the purpose of determining the effect of the various chemicals upon it indicated that the other animal forms at least were such as to be resistant to such a process, and the bacteriological studies made by various sewage disposal students indicated that the bacteria should be able to resist flooding for a considerable period of time. It was therefore determined to test submergence as a possible method of destroying the sewage filter fly.

Accordingly, a series of experiments were undertaken by the junior author to test out this method of destruction. In these experiments the filter stones with their covering of film were taken directly from the filter bed and placed in 6-inch burnt-clay non-glazed flower pots, the drainage hole of which was stopped up. An average of about one quart of stone was placed in each pot, and the pots set into the bed so that their tops were practically flush with the surface. As the spray played, the pots became filled with water and the stone contained in them completely submerged. The length of time was the only variant. After the treatment was completed, the stones were examined for signs of life in the larvæ and pupæ. The condition of the film was determined by making a smear on the glass slide and examining it under the microscope. The active forms of protozoa were used as an index to the life of the film. Putrefication was determined by odor only. The following table will set forth the detail of the results:

FLOODING EXPERIMENT CARRIED OUT IN FLOWER POTS

Length of Time Flooded	Condition of Larvæ and Pupæ	Condition of Film
16 hours	Alive	Alive
18 hours	Alive	Alive
22 hours	95% dead	Alive
24 hours	Dead	Alive
32 hours	Dead	Alive
36 hours	Dead	Slight putrefication
48 hours	Dead	Putrefaction

This set of experiments was repeated three times with exactly the same results. It thus seemed that submergence for twenty-four hours destroyed 100 per cent of the larvæ and pupæ and apparently did not injure the film.

Realizing that the results in the flowerpots might differ from results of the same treatment on the filter bed, we asked the Joint Sewer Committee to make the necessary preparations to submerge one quarter of the filter bed involving somewhat less than half an acre. Although the problem of blocking off the drainage pipes from this section was a difficult one it was undertaken and carried out. The entire supply of effluent was turned into one dosing tank and run into this quarter of the filter. In three hours and thirty minutes after starting, this quarter of the bed was submerged. The submergence was completed at 1.30 p. m. and the water was maintained on the bed continuously from that time until 1.30 the following day, when the sewage was turned off this quarter entirely into the other parts of the bed. In about two hours after the sewage was turned off this quarter, some of the stops were knocked out of the drains and samples of the effluent caught as it came from the treated section of the bed. Thousands of larvæ and pupæ, particularly larvæ, were swept out and careful examinations of samples showed that 100 per cent were dead. For an hour after this time the senior and junior authors watched the effluent as it came from the filter into the final Imhoff tank. Constantly during this period the water swept by well filled with these dead larvæ and a smaller number of dead pupæ. In no case were any found to be alive. This submergence was completed on Saturday afternoon. The filter was allowed to stand without water over Sunday. The following Monday the stoppings were all removed and the sewage turned back on this quarter of the bed as usual. Tests of the effluent of the filter for a week afterward by the manager of the plant, Mr. John R. Downes, indicated that the activity of the film had been in nowise impaired.

It thus seems that the sprinkling sewage filter fly, *Psychoda alternata*, and its less important relative, *Psychoda cinerea*, may be destroyed by

the simple process of submerging the sprinkling sewage filter for twenty-four hours with the ordinary sewage as delivered to the sprinkling filters without in any way impairing the efficiency of the film upon which the activity and efficiency of the sprinkling sewage filter depends.

THE USE OF PALLIATIVES FOR MOSQUITO BITES

By H. E. Ewing, *Ames, Iowa*

In our literature on mosquito control we find many references to the use of different agents for the alleviation of the itching pain that follows the bites of the mosquito. Most of these recommendations have been based upon "hearsay" reports of acquaintances who had tried them, or have been culled from a voluminous correspondence in which different individuals had related their experience with different remedies which had proved helpful. Having tried some of these palliatives with little effect, the writer determined to make an experimental investigation of the remedial qualities of the different chemicals that had been suggested.

Theory of Action of Palliatives

In most cases apparently there has been no theory as to the action of the palliatives used or valid reason for applying the same. Each individual apparently tried what accidentally suggested itself to his mind or what happened to be on hand. At one time it was believed that the inflammation and itching sensations caused by mosquitoes were due to formic acid or at least to some toxin that was neutralized by the application of an alkali. The toxin was supposed to be secreted by a specialized lobe of each group of salivary glands. This was the theory of Macloskie. The more recent work of Schaudinn and Major Williams have shown that the toxin comes not from the salivary glands but from one of the esophageal diverticula, and appears to be produced by the symbiotic action of a fungus. These more recent demonstrations have demolished the theories based on the belief that the beneficial action of an alkaline solution came through its neutralizing effect upon the acid poison of the salivary glands.

Methods

In testing the various solutions for their effect as palliatives the usual experimental methods were employed. Checks were run in each case and comparisons made with untreated bites of mosquitoes. Two or more mosquitoes, usually of the same species and always from the same environment, were allowed, or induced, to feed simultaneously

in a similar situation. These mosquitoes were always permitted to feed to repletion, after which the palliative was applied to one or more puncture spots and comparisons made with the untreated wounds for a period of approximately an hour, or until all effects of the mosquito punctures had subsided. In these comparisons special attention was paid to the amount of itching or pain felt at the treated punctures in comparison with the amount felt from the untreated ones. The amount of swelling, the size and color of the wheal, and its duration also, were observed.

Errors

Since in the application of these palliatives it was necessary to rub the injured spot somewhat, and since rubbing is known to affect the itching sensation, as well as the inflammation of the injured area, it was decided to observe the effects of a vigorous rubbing of the wound-puncture.

Abnormal wounds from injured mosquitoes or those evidently deficient in venom were excluded. Three mosquitoes were found that were apparently entirely devoid of venom. Their bites were not felt, and their presence would not have been detected except by sight, although each was allowed to feed to repletion. In such cases there was no swelling or discoloration of the skin following the puncture.

Normal Injury from a Mosquito Bite

The time required for engorgement to repletion was found to vary from one minute and twenty-five seconds to three minutes and twenty seconds. The variation in toughness of the skin appeared to be the chief factor affecting it. Aside from the sharp itching pain, that starts usually the instant the beak is inserted, no injury is noticed during the engorgement.

A few minutes after (usually about five) the first pain is felt there appears, at the point of puncture, a minute white elevated spot. This is the beginning of the characteristic wheal. It continues to grow and eventually, at the end of from twenty to forty minutes, reaches its maximum size. Soon after the wheal appears, the skin around it turns reddish. This reddish area increases in size with the development of the wheal. From thirty to forty minutes after the bite was inflicted the wheal began to diminish. As it diminished it took on a flesh color. The reddish area slowly disappears, and within one or two hours all noticeable injury is gone.

Effects of Rubbing

Rubbing of mosquito bites is almost universally practiced by the public and equally universally condemned by entomologists. The

experiments performed to ascertain its effect were very surprising. Rubbing apparently rapidly diffuses the toxin. It increases the itching at first, but if vigorously practiced, usually causes all swelling to disappear in about one-half or one-third the normal time, and with the disappearance of the swelling the itching also vanishes. Rubbing destroys the normal symptoms observed following the bite of a mos-

Date	Palliative Used	Times Applied	When Applied	Effect on Pain in Comparison with Check	Size of Wheal Compared with Check	Miscellaneous Notes
June 18	Soap	1	Immediately after bite	Same as in check	Larger	Had no effect
July 8	Soap	2	Soon after	Itching slightly less	Somewhat less	Value slight
July 8	Soap	3	Soon after	Itching less	Same size	Value slight
June 18	Bay rum (58% alc.)	2	Soon after bite	Somewhat less	About same size	Had slight effect
June 21	Alcohol (95%)	2	Soon after bite	Somewhat less	One-half as large	Decidedly helpful effect
June 22	Alcohol (30%)	2	Soon after bite	No effect	Three times the area	No beneficial effect
June 22	Alcohol (30%)	2	Soon after	Pain greater	Equal to check	No beneficial effect
June 22	Alcohol (30%)	3	Soon after	Same as in check	One-third larger	Effect injurious
June 22	Hydrogen peroxide	1	Immediately after	Same as in check	Broader but not so high	No effect
June 22	Hydrogen peroxide	2	Soon after	More pain than in check	Considerably larger	Apparently injurious
June 23	Hydrogen peroxide	3	Soon after	Same as in check	Slightly larger	Of no benefit
June 25	Hydrogen peroxide	Constantly for 15 min.	Soon after	Same as in check	Same size	No benefit
June 27	Glycerine	1	Soon after	Greater	Same size	Glycerine remained on skin until swelling left
June 27	Glycerine	2	Soon after	Greater	Larger	No value
July 5	Ammonia (Conc. ag. sol.)	1	Soon after	Itching less	Larger	
July 5	Ammonia (Conc. ag. sol.)	2	Soon after	Itching much less	Same as in check	Considerable value
July 5	Ammonia (Conc. ag. sol.)	3	Soon after	Itching much less	Same as in check	Has value as palliative
July 10	Ammonia (dilute)	1	Soon after	Same as in check	Same as in check	No effect as palliative
July 10	Ammonia (dilute)	2	Soon after	Same as in check	Larger	No effect
July 10	Indigo in water	1	Soon after	Less	Same as in check	No effect
July 10	Indigo in water	2	Soon after	More than in check	Same as in check	No value
July 10	Indigo in water	3	Soon after	Same as in check	Less	No value

quito. The wheal that develops is not so high, or as hard as when not rubbed, and it lacks much of its whitish color. Likewise, the reddish area around the wheal is not differentiated. It is merged with the diffuse wheal and is of the same color. The effects of rubbing must be kept clearly in mind in interpreting the value of palliatives.

Results

The results obtained by testing the following; soap, bay rum, 95 percent alcohol, 30 percent alcohol, hydrogen peroxide, glycerine, concentrated solution of ammonia, weak solution of ammonia, and indigo in water are given above in tabular form.

Summary

1. Hydrogen peroxide, glycerine, and indigo apparently are worthless as palliatives, and not only fail to have any alleviating effect on the injury from the mosquito bites, but apparently augment the injury. However, this apparent augmentation probably comes from the rubbing which has the effect of increasing the itching pain at first and of diffusing the wheal, although usually neither the pain or swelling lasts as long.

2. Soap, bay rum, dilute alcohol, and dilute ammonia have but slight value. Dilute ammonia is to be preferred of the four. If soap is rubbed into the skin some relief is obtained, which probably comes chiefly from the rubbing.

3. Strong alcohol and strong ammonia have the greatest value as palliatives, both giving a marked reduction in pain. There is a tendency for the former to leave a hardened lump in the place of the wheal, and the latter is rather harsh on the skin.

A NOTE ON THE LIFE CYCLE AND FERTILITY OF THE BODY LOUSE (PEDICULUS CORPORIS)

By R. H. Hutchinson

The following is a record of the rate of development and of the deposition of eggs of the body louse at body-surface temperature with unlimited opportunities for feeding. It is of special interest as giving a record of deposition higher than any heretofore published. It fully confirms the data given by Nuttall (Biology of *Pediculus humanus*, Parasitology, Vol. 10, No. 1) on the duration of the life cycle, and affords further evidence in support of his claim that the fertility of body lice has been greatly underestimated and that a true idea of

their powers of reproduction can only be obtained when they are provided with full opportunity for feeding.

The method used in this experiment was practically the same as that described by Nuttall as the "wristlet method." A small pill box was used, in the bottom of which was a large opening covered with chiffon. There was no opening provided in the top of the box. Thus, when the chiffon-covered opening of the bottom of the box was applied to the arm, there was little or no opportunity for evaporation and therefore the humidity was doubtless higher in this box than in the ones used by Nuttall in his experiments. The temperatures inside the box varied from about 30° to 35° C.

At 11.30 a. m., May 1, some infested clothing was taken from a patient admitted to Charity Hospital, New Orleans, La. From this clothing ten females were removed and placed on a small piece of clean cloth and kept in an incubator over night. Between 4.00 p. m., May 1 and 9.00 a. m., May 2, fifteen eggs were laid. Eleven of these were attached to the cloth, and were kept in a small glass vial in the incubator, at temperatures ranging from 30° to 33° C. Nine larvæ emerged between 4.00 p. m., May 8 and 9.00 a. m., May 9,—an incubation period of seven days.

These larvæ were at once placed on a small piece of dark serge cloth and put in a pill box as above described. The box was then applied to the arm and worn continuously, night and day, except for about one hour each morning when examination was made. The first molt occurred before 9.00 a. m., May 12; the second molt, before 9.00 a. m., May 14; the final molt, before 9.00 a. m., May 17. There was, therefore, a first larval stage lasting three days; a second stage lasting two days, and the third stage lasting three days, and a total period from emergence to adult of eight days. The period from deposition of the eggs to the final molt was fifteen days, and from egg to egg was sixteen days.

One male and one female were isolated from this lot at 9.30 a. m. May 17, and placed on a bit of clean cloth in another pill box. This was worn on the arm continuously as before. No eggs were laid before 5.00 p. m. Between 5.00 p. m., May 17 and 9.00 a. m., May 18, five eggs were laid. This and subsequent depositions are listed below. The eggs, in most instances were laid on the cloth, but occasionally were found on the chiffon of the floor or even on the sides of the box.

RECORD OF EGGS DEPOSITED BY ONE FEMALE *P. CORPORIS* IN WRISTLET

1918 Date	Time of Examination	Hours Since Last Examination	Number of Eggs
V-18	9.00 a. m.	16	5
19	12.30 p. m.	27½	13
20	9.30 a. m.	21	11
21	9.00 a. m.	23½	13
22	9.00 a. m.	24	13
23	9.00 a. m.	24	13
24	9.00 a. m.	24	13
25	9.00 a. m.	24	14
26	10.00 a. m.	25	13
27	9.30 a. m.	23½	14
28	9.00 a. m.	23½	13
29	9.30 a. m.	24½	14
30	9.00 a. m.	23½	12
31	9.00 a. m.	24	11
VI- 1	9.00 a. m.	24	13
2	10.30 a. m.	25½	12
3	9.00 a. m.	22½	11
4	9.00 a. m.	24	11
5	9.00 a. m.	24	12
6	9.00 a. m.	24	9
7	9.30 a. m.	24½	12
8	10.00 a. m.	24½	9
9	9.00 a. m.	23	8
10	9.00 a. m.	24	6
11	10.00 a. m.	25	1

Both the male and female were found dead on the morning of June 11. This record shows a total of 276 eggs deposited during a period of 25 days,—an average of 11 eggs per day and a maximum of 14 eggs in 24 hours. Of records previously published the one nearest approaching this is given by Nuttall, in which he obtained 272 eggs in 29 days, averaging 9.7 per day.

COÖPERATION AMONG AGRICULTURAL WORKERS

By JOHN J. DAVIS, *Lafayette, Indiana*

In his address before the Entomological Society of America at Philadelphia, Pa., December 30, 1914, on the Ecological Foundation of Applied Entomology,[1] Dr. S. A. Forbes said, "It is when we search for specific reasons for our successes here and our failures there that we are driven to a scrutiny and analysis of controlling conditions of every description, and so find ourselves involved in studies so far outside entomology, commonly so-called, that we are obliged to apply for assistance to the physiologist, and the chemist, and the physicist, and the meteorologist, and the geographer, and the agriculturist, and the animal husbandman, and the bacteriologist, and the physician, and the sanitarian, or in a word, to the ecologist, who from the nature of his studies, must, if he is thoroughly to cover his field, be something of each and all of these, and still something more." This thought so

[1] In Annals Ent. Soc. Amer., vol. 7, No. 1, Mar., 1915.

appropriately given has been a continuous reminder to the writer in his entomological investigations of the error we so frequently make in considering our problems from the narrow angle of our own particular field.

Agriculture is a study of the interrelations of all branches of agriculture, a complex of gigantic proportions and too great for the conception of a single mind. In the early days of scientific agriculture the workers were few and each was by necessity more or less acquainted with the most improved practices in all branches of agricultural work, as evidenced by the fact that the teacher of agriculture was frequently obliged to conduct classes in soils and crops, horticulture, animal husbandry, etc. To be sure he may have been especially interested in some phase of the subject, but nevertheless a general knowledge was essential. This plan of work has gradually changed until now we have the various investigations for each branch, and even these are subdivided and thus we have specialists for the various subdivisions. For some years, and especially since taking up intensive studies on insect problems of general farm crops, the writer has recognized the need of coöperation and freer intercourse between the different and increasingly complex branches of agricultural education. We feel that there is no more important work than the coördination of the many farm problems, and this cannot be treated as an individual problem but must be the combined work and ideas of complex investigations from every branch of the subject. Too often the entomologist in considering methods of control attacks the problems from the purely entomological standpoint, neither thinking nor apparently caring whether the suggestions may meet with the requirements of the approved plan of the agronomist, chemist or forester. Recommendations have been made seriously conflicting with approved farm practices which could doubtless have been revised to meet all requirements had the author been familiar with approved farm methods or better, if he had consulted with specialists in that phase of agriculture touching on his recommendations. It cannot be expected that an entomologist shall be familiar with all developments and approved practices in agronomy, nor the agronomist with problems entomological; but it is possible for the agronomists and entomologists, plant pathologists and entomologists, and others to freely consult on problems which are directly or indirectly connected and thereby reduce to a minimum conflict in advisory measures. The agronomist can see points of utmost importance in the control of insects which might never be considered by the entomologist, and the chemist would see features from his point of view which would be of invaluable help, and so on indefinitely, and it occurs to the writer that there lies within our reach a wonderful source of informa-

tion which would be made available by incorporating in our routine freer consultation with our coworkers, to say nothing of the benefit derived by securing recommendations of mutual value. Entomologists are not alone to blame for this condition; indeed they have in known cases endeavored to coöperate and seek advice from other branches of agriculture.

In our Hessian fly investigations we are dealing almost wholly with agronomic practices. Wheat sowing experiments have been started at various localities to determine not only the favorable date for sowing wheat to avoid the fly, but to determine the proper sowing dates irrespective of fly, and effects of quick-acting fertilizers on the crop to overcome injury or to permit sowing wheat after the fly-free date and avoid any possible harm often attributed to late sowing. Aside from sowing experiments plots where complete meteorological data are obtained, plots are grown to determine effect of time of plowing and cultivation of ground on resulting wheat crop in its relation to fly, effects of variously plowing the stubble to destroy fly, fly-resistant values of different varieties, et cetera, all of which are directly or indirectly of importance to the entomologist studying the Hessian fly, joint-worm and similar wheat pests and at the same time of equally great importance to the agronomist. Conversely the agronomist cannot lose sight of the insect problems in his investigations. We recently had the privilege of exhibiting and explaining results of our wheat sowing experiments to one of the best informed experts in soil and crop work, who after studying the results remarked that he could see how they might easily misinterpret results by failure to take into consideration the rôle played by insects. The interrelations between agricultural methods must be more closely studied as the problems become increasingly intensive, and to do this it becomes necessary that workers in different branches consult more freely and settle disputed or questionable points from the standpoint of agriculture in its broadest aspect. This was aptly illustrated in a recent conference at Washington, D. C. called by Mr. W. R. Walton, in charge of cereal and forage crop investigations of the Bureau of Entomology to consult with the Bureau of Plant Industry and secure their coöperation and advice on the suitableness of certain rotations which would enable the entomologist to recommend and insure a more universal practice of plowing under wheat stubble to destroy Hessian fly and joint-worm. This conference obtained for the entomologist recommendations which were agreeable to the crop experts and adaptable to the insect problems involved.

The individual investigator can most often plan his experiments from his own particular point of view and his knowledge of the prob-

lems to which it is related and can often continue it to a point nearing completion, varying according to the factors involved; but if the problem touches directly or indirectly on any related branch of agriculture he should under all circumstances, for the sake of uniformity, usefulness and stability, consult with his colleagues in that particular related branch for corroboration and advice. We have attempted to plan our work along these lines with favorable results. In the Hessian fly program the work was planned in accordance with the needs of entomology but the agronomist was consulted on points dealing with fertilizers, cultivation and the like for expert advice, and the practical and successful farmer similarly consulted for advice on the practical application of certain phases. In many of our investigations of farm crop pests, surveys have been made of one, two, or four square miles in infested districts, records being made of every possible factor which might be of importance in interpreting results, such as rotation, methods of cultivation and fertilization, possible barriers of timber or buildings, contour, meteorological influence and the like. These surveys have been mapped out and in the case of insects having a life cycle greater than one year, such as *Lachnosterna*, the records for the individual fields have been followed year after year, keeping even such detailed records as growth of vegetation on the ground at different seasons; for this little point is of much importance in considering subsequent infestations of white grubs if the observations are being made during a year when the parents of white grubs—the May-beetles—are abundant. A survey of this kind is of greatest importance in explaining the interrelations of the agricultural problems, and at the same time often shows by contrast just what conditions have affected one field in one way and an adjoining field differently, or have brought about an increase in insect pests in one and a decrease in another similarly located field.

The above discussion is intended to emphasize the need of keeping closely in touch with workers in all branches of agriculture and to encourage freer exchange of ideas and plans between agronomists, entomologists, plant pathologists, chemists, foresters, animal husbandmen, meteorologists and others. Likewise the agricultural investigator, and especially the entomologist, should not lose sight of the ecological applications for, as Doctor Forbes has said, the student in entomology should be required to complete certain courses in ecology as prerequisites to their courses in entomology, or at least ecology should be required as a necessary part of entomological training. This likewise applies to the agricultural student. He is required to complete certain courses in agronomy, chemistry, farm mechanics, animal husbandry, entomology, etc., and here his requirements end. He becomes familiar

with soils and crops from the point of view of the agronomist, with swine or poultry problems from the conception of one who has made a special study of these particular subjects, but the average student is not able to coördinate these studies as could be done if he had first obtained a knowledge of applied ecology in its relation to agricultural topics.

OBSERVATIONS ON THE SILK INDUSTRY IN CHINA

By C. W. Woodworth

One of the largest industries, at least from the standpoint of exports, is the production of silk. The great center of its production is the lower Yangtsee Valley between Nanking and Shanghai and southward to Hangchow.

I have had the opportunity of travelling over this whole district and while it was in midwinter I was still able to get a good idea of the extent of the industry and learn much about the practices.

Through this region the prevailing tree cultivated is the mulberry. The trees are small and planted quite thickly, perhaps ten feet apart, and kept cut back with the trunk seldom above six feet high, but not winter pruned. The trees are cut back during the summer at the close of the silkworm feeding season almost as severely as the short pruned grapevines and produce a fine growth of sucker-like branches, often 3–4 ft. long, before winter. It is from these that the leaves are gathered the following spring. During the winter these are often tied together and I am not sure that I know exactly what for; it looks as though it was to keep them up out of the way when cultivating.

Most mulberry orchards are well cultivated, but in many cases the trees are planted on and among graves, when they are not cultivated at all and it looks as though they did as well as any others.

During the feeding season mulberry leaves are sold on the streets, like vegetables and command a good price. Nearly every season there are not enough leaves to supply the worms grown. There is a movement on foot to greatly increase the planting of mulberries. The University has just planted about 15,000 cuttings to help in this work.

Because of the shortage of leaves, early hatching and small early maturing varieties are favored though they have the large French and Italian varieties in the schools. It seems hard to make the farmer see the advantage, they object that these big worms eat too much!

One of my problems is to see whether they are right. I have gathered together sixty-four varieties (some of which may be duplicates)

of eggs and propose to rear them in comparison with each other and then will know better which is most economical. I think the collection of eggs I now have is probably the largest assortment ever brought together and it is probable that I will have a great many more provided my plans of a short course on silk rearing are not prevented by war or pestilence which may be operating at once here in Nanking.

In any case, however, I expect to be able to rear the eggs that I have and we have secured the largest orchard of mulberries in Nanking or hereabouts and our supply of leaves is therefore assured. I estimate they will produce about three or four tons of leaves.

I have twenty lots of the common local strains of silk from as many localities. These are produced in the usual Chinese way and are untested for disease, which, I understand, is very prevalent. The remainder are produced according to the Japanese methods, which in turn were based on the methods devised by Pasteur.

The silk merchants have just established an organization for extending and popularizing the use of tested eggs in order to improve the quality of cocoons. Japan has increased her production of silk the last few years till it exceeds China's production and that ought to be enough to wake up the people of China to the realization of the need of better methods.

The Chinese government has established a number of silk schools and many agricultural schools in all of which, in this district, the rearing of silk and testing of eggs are taught.

I had the pleasure of visiting a new 50 basin filature just erected at Hangchow. The machinery was all Japanese and looked very satisfactory.

Japan is thus having a great and good influence on the silk industry of China, in the teaching at the schools, in the factories and in the spirit of emulation which her success in the silk industry has awakened in the progressive people among the Chinese.

CLYTUS DEVASTATOR, A NEW PEST OF THE FLORIDA ORANGE[1]

By E. A. Back, *Bureau of Entomology*

The insect discussed in this paper is not new to Florida. Neither is it new as a pest of *Citrus*, but it apparently has never before been recorded as a pest of the Florida orange. The purpose of this paper is to call attention to its capacity to injure orange trees in Florida should conditions become favorable for its increase.

[1] Published with the consent of the Secretary of the U. S. Department of Agriculture.

History of Infestation

During April, 1910, Mr. S. C. Cobb of Anna Maria Key, Florida, wrote to the Secretary of Agriculture that his attention had been called to the condition of an orange grove in his district that might assume a real menace to the orange industry of Manatee County; that without any apparent warning worm holes began appearing about six months previous in the bark of the trunk and limbs of certain trees, and that they continued to appear, even at the time of his writing, in spite of the fact that as the holes appeared they were promptly filled with sulphur and tar, and plugged with wood. Portions of branches, sent later to the Bureau of Entomology, were submitted to Mr. E. A. Schwarz who wrote Dr. L. O. Howard that the material "plainly shows that the apparently healthy wood of the orange branches in that section of Florida is attacked by a round-headed borer (family Cerambycidæ, order Coleoptera). This represents to my knowledge a new and apparently most destructive enemy to orange trees in Florida. There are only a few inside borers known among the Cerambycidæ, and the work in the sample sent by Mr. Cobb most closely resembles that of our common black locust borer (*Cyllene robiniæ*). There is very little doubt in my mind that this new orange borer belongs to the same genus. Should I be correct, there is in southern Florida only one species of this genus capable of doing this work, viz., *Cyllene crinicornis*, a species extremely common in the West Indies and throughout Central America, semitropical Texas and semitropical Florida." Under date of May 10, Doctor Howard wrote Mr. Cobb that it was Mr. Schwarz's fear that his trees were infested by a "heretofore unrecorded and dangerous enemy of orange."

Investigation of Injury

At the request of Doctor Howard, the writer visited Anna Maria Key during the later part of May, 1910. On Perico Island, a small land area close to Anna Maria Key, four trees were found affected by borers, two very seriously so, as indicated by the illustrations of plate 1. The remaining trees of a small grove were unaffected. The two badly affected trees were so damaged by the borers that their owner had cut back the branches to mere stubs, and was willing to grub out the trees that a careful examination might be made of them.

It is doubtful if words can describe the nature of the injury better than the illustrations. The trees were small, scarcely seven inches in diameter and had evidently grown well previous to attack. The larvæ were found making their tunnels through all portions of the wood, and there were no evidences that their attack was of a secondary nature. When young, they feed upon the inner bark and sapwood, as shown

in figure 2 of plate 12, where their frass-plugged winding burrows stand out in contrast to the discolored sapwood. As they become older, they bore into the harder and older wood as showed by the sections of the trunk (Pl. 12, fig. 1). Not only were larvæ found working in various parts of the trunk and in the stubs of the larger branches, but even in the roots, both large and small. Fully half of the stump illustrated (Pl. 12, fig. 2) was beneath the surface of the ground, yet the removal of the bark brought to light the surface feedings of the young larvæ on the roots and the burrows of the older larvæ in the center of the roots, near the crown. The mature larva feeding in the hard wood, has the habit, similar to that of the round-headed apple-tree borer (*Saperda candida*), of eating its way to the surface, as indicated on the left of the cut surface of figure 12, plate 1, after which it retreats a short distance from the bark to pupate. The adult, upon emergence, gnaws a hole about three eighths to one-fourth of an inch in diameter in the bark and escapes.

Identification

Adults were reared and forwarded to Mr. Schwarz who at once pronounced them to be *Clytus devastator*, an insect first described by MM. Delaporte de Castelnau and Gory in 1836 (1), and named *devastator* because of the great injury it was known to cause *Citrus* in Cuba. The authors say "Le nom que nous lui donnons est tire de ses habitudes, ces insectes causant de grands degats aux citronniers." The adult beetles are normally a trifle over half an inch long, but vary greatly in size and in the color pattern of the elytra. The authors of this species give (1) an excellent colored figure of an adult which bears a pattern in white. The pattern of an adult reared from the orange tree at Perico and illustrated (Pl. 12, fig. 3) is one of many variations to be found in this species among the material of the U. S. National Museum.

Distribution and Hosts

The specimens of this species in the U. S. National Museum have been captured in Cuba at Cayamas (January, February, May, 1910, by E. A. Schwarz) and at Central Constancia (May, 1914, by J. F. Merrill); in Florida, at Palm Beach (May, 1903, by E. A. Schwarz), Key West (April and May, 1903, by E. A. Schwarz), Paradise Key (Royal Palm Park, May, by T. E. Snyder), Chase (March) and Perico Island at mouth of Tampa Bay (June, 1910, by E. A. Back).

At Cayamas adults were reared from "Cuban mahogany." The specimens from Chase, Fla., were reared from pomegranate (U. S. N. M., Hopk. No. 9902 f). The specimen from Paradise Key was caught

on the wing. Aside from the general statement made by Delaporte de Castelnau and Gory, and by D. Ramon de la Sagra (3) who says "Segun M. Laporte, este insecto causa grandes destragos en los limoneros," the specimens of the writer are the only ones reared from *Citrus*.

Conclusions

Clytus devastator, a Cerambycid borer, was first described as a serious pest of *Citrus* in Cuba in 1836, and has since been recorded by collectors, besides in Cuba, at Key West, Chase, Paradise Key and Palm Beach on the East Coast of Florida, and at Perico Island, close to Anna Maria Key, at the mouth of Tampa Bay on the West Coast of Florida. It has been reared from "Cuban mahogany," pomegranate (*Punica granatum*) and *Citrus* (orange), and, according to Mr. E. A. Schwarz, has as its preferred host the common mangrove (*Rhizophora mangle*). Aside from the original statement that it was a serious pest of *Citrus* in Cuba, it has not been reared from *Citrus* until it was found damaging orange trees on Perico Island, Florida, in the spring of 1910. It has demonstrated its capacity to become a serious pest in Florida, and with the extension of the citrus industry still further south into more tropical portions of the state, or with a rearrangement of its host relationships following further development of the country, it may assume an important rôle as a pest of *Citrus*.

Bibliography

(1) Delaporte de Castelnau and Gory. Monographie du Genre Clytus, Rapport fait a l'Academie Royal des Sciences de France, dans la séance du 4 Janvier, 1836, p. 17, pl. 4, fig. 18 bis.

(2) Dejean. Catalogue des Coleopteres, 3rd Edition, 1837, p. 357 (*Clytus cordiger*).

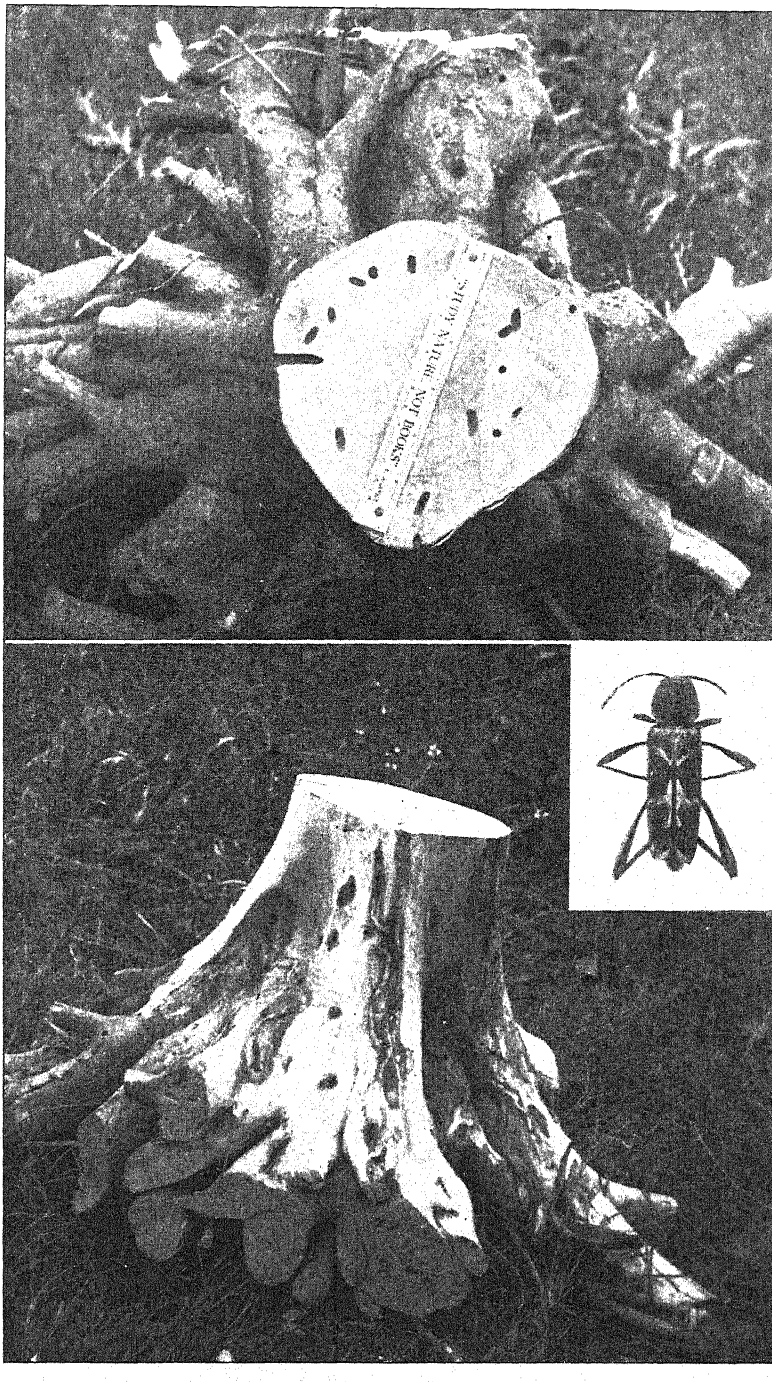
(3) D. Ramon de la Sagra. Historia Fisica, Politica y Natural de La Isla de Cuba, 1857, Vol. VII, p. 111. (*Clytus devastator*).

Explanation of Plate 12

Fig. 1. Cross section of trunk of orange tree showing the burrows of *Clytus devastator* and emergence hole on one of the large roots.

Fig. 2. Another view of same stump, showing not only the emergence holes of adults and the burrows of the more mature larvæ in the roots, but also the frass-plugged channels made in the sapwood by the younger larvæ. Note that secondary fungus attack has caused a discoloration of the sapwood near the burrows.

Fig. 3. Dorsal view of adult beetle, *Clytus devastator*, reared from stump. About twice normal size.


STUDY NATURE, NOT BOOKS

INSECT ENEMIES OF THE CHINCH-BUG

By W. P. Flint, *Assistant Entomologist, Urbana, Ill.*

While the chinch-bug occupies a very prominent place in the writings of economic entomologists, up to the time of the discovery of its egg parasite, *Eumicrosoma benefica* Gahan, by McColloch in Kansas in 1913, but very little detailed study had been given to its predaceous or parasitic insect enemies.

Walsh in some of his earlier writings on the chinch-bug says that it is attacked by four species of ladybugs, the most efficient being *Hippodamia maculata.*

Henry Shimer described in 1865 a new species of Chrysopa (*C. illinoiensis*) which he found in a cornfield feeding upon chinch-bugs, and reported that one of the larva of this species which he kept in confinement ate a dozen in quick succession. Later he reared *Hippodamia maculata* from egg to adult by feeding it upon nothing but chinch-bugs.

LeBaron mentions lace wing flies and ladybugs as the only insect enemies of the chinch-bug, but says that chinch-bugs are fewer than usual on hills of corn which have ant-hills at their base.

Thomas states that the chinch-bug is fed upon by *Hippodamia maculata.*

Riley says that the above mentioned insects feed upon the chinch-bug, and that he thinks ants are of some benefit in reducing its numbers.

Forbes found from an examination of the stomach contents of a number of the common ground beetles found in fields infested by the chinch-bug that about a fifth of the food of *Agonoderus pallipes* was derived from chinch-bugs.

Webster says that the chinch-bug has no insect enemies of importance; he mentions that it is infested by a species of Mermis or hair snake, and that its worst insect enemies are to be found in its near relatives, the insidious flower bug (*Triphleps insidiosus*) and *Milyas cinctus.*

Headlee and McColloch report that besides the above mentioned insects, they have occasionally seen the false chinch-bug, *Nysius angustatus,* feeding upon the chinch-bug, and have repeatedly found three species of ground beetles, *Harpalus compar, Evarthrus sodalis,* and *Anisodactylus harpaloides* eating it. They also saw a cricket feeding on chinch-bugs and two of the small ants commonly found in grain fields, *Solenopsis molesta* and *Monomorium minimum,* carrying chinch-bug eggs and dead adults.

A few other insects have occasionally been found to feed on the chinch-bug but it has been generally supposed that predaceous insects are only a very slight check on its increase.

During the recent outbreak of this insect in Illinois (1909–1915) a number of observations on its predaceous enemies were made by the writer while conducting experiments on methods of chinch-bug control. In the summer of 1915 a number of insectary experiments were made to learn just how many chinch-bugs the more abundant of these predaceous insects would eat, and how common they were in the field. Those most commonly found feeding on the chinch-bug throughout the infested area in Illinois were adults and nymphs of the damsel bug, *Reduviolus ferus*, larvæ of Chrysopa and Hemerobius, adults of the small ground beetles, *Blechrus glabratus* and *B. pusio*, nymphs and adults of *Pagasa fusca*, larvæ of several species of Coccinellidæ, and nymphs and adults of the common flower bug, *Triphelps insidiosus*. The ground beetles most common in infested fields were not found to feed on chinch-bugs to any extent. *Casnonia pennsylvanica* ate small numbers of them and *Agonoderus pallipes* ate dead bugs and molt skins. Ants were never observed to attack living chinch-bugs in the fields although they would do so when the bugs approached an ant nest. Several of the species common in cornfields were noticed carrying dead bugs. Cincindelid adults were seen to eat small numbers of chinch-bugs along barrier lines.

The following notes give the detailed results of the studies of the above mentioned insects. In these experiments single specimens of the predaceous insects to be tested were placed in clean vials with a known number of chinch-bugs of known stages of growth. A few sections of foxtail grass were also placed in the vials as food for the chinch-bugs, and the vials stopped with cotton. These vials were examined daily and fresh food for the chinch-bugs added and fresh bugs as needed. By the use of check vials in which only chinch-bugs were confined, it was found that they could be kept in a normal state of growth in this way, several lots being carried through from egg to adult.

Chrysopa oculata and *C. rufilabris*. Chrysopa larvæ were abundant in all fields of grain infested by the chinch-bug. They were often seen feeding on chinch-bug nymphs especially in cornfields where they would be found behind the boots of the lower leaves where the chinch-bugs were most abundant. In a number of cases chrysopa larvæ were seen to suck from three to five chinch-bugs in the course of ten minutes. The insectary experiments were first started with chrysopa larvæ collected in the field in different stages of growth, but were later carried on with larvæ hatched from eggs in the insectary.

These experiments showed that where first and second instar chinch-bugs were offered as food, the chrysopa larvæ ate from four to six per day and that about 100 of these nymphs would be required for the chrysopa to complete its growth from egg to adult. Counts made in cornfields after the first of August showed that chrysopa larvæ would average about six per hill of corn in fields where chinch-bugs were abundant.

The damsel bug, *Reduviolus ferus*. During the past chinch-bug infestation this insect has been noted as probably the most common of any of the insects feeding upon chinch-bugs in all situations.

Insectary experiments with this species showed that both nymphs and adults fed readily on chinch-bugs, that they seemed to prefer chinch-bug nymphs in the third or fourth instar and occasionally fed on adults. An average of about two chinch-bugs per day were eaten where the observation extended over a period of two to three weeks.

Blechrus glabratus. This small, very active beetle apparently feeds only on chinch-bugs in the first and second instars, its size making it very difficult for it to overpower the larger bugs. In the insectary experiments one of these beetles ate eighty-eight chinch-bugs in twenty-six days. In another case eighteen first instar chinch-bugs were eaten in twenty-four hours.

These beetles can be found in the adult stage in all grain fields after the middle of June. They have been taken in fairly large numbers in the hibernating quarters of chinch-bug, especially in the bases of the large clump farming grasses.

Another fairly efficient chinch-bug predator, although not occurring in grain fields in very large numbers, is the Nabid, *Pagasa fusca*. All stages of this insect from small nymphs to adults have frequently been seen in infested fields feeding upon the chinch-bug. In the insectary experiments with this insect all specimens used died during the molting process although in some cases one or two molts were successfully completed. For this reason no complete records of the number of chinch-bugs eaten by individuals of this species was obtained. This insect seems to prefer the later stages of the chinch-bug and has been seen a number of times in the fields feeding upon adults.

In the insectary experiments this species ate from one to two chinch-bugs per day for a period of from five to thirty-six days.

During the hatching period of the second brood of chinch-bugs one of the most efficient of their enemies is the predatory flower bug, *Triphleps insidiosus*. This insect has been seen in small numbers in infested fields of small grain but has been found in abundance in the cornfields during late July, August and September. The small size of this insect makes it impossible for it to feed upon any but first

and second instar chinch-bugs; both nymphs and adults have been seen a number of times in the field feeding on the early stages of the chinch-bug. In cornfields it would sometimes be found to average five and six to the stalk of corn over the entire field.

The insectary experiments with this species showed that about twelve first instar chinch-bugs were required for the flower bug to complete its growth to adult, and that these were taken at the rate of a little less than one per day. Their appetite for chinch-bugs did not decrease when the adult stage was reached as they still continued to feed at about the same rate as the nymphs.

Only two of the ground beetles common in the chinch-bug infested field could be induced to feed upon chinch-bugs in the course of the insectary experiments. *Casnonia pennsylvanica* has been seen feeding upon chinch-bugs in the stubble fields but only in one or two cases during the past five years. The results of the insectary experiments do not show that this beetle would be of much importance in reducing the number of chinch-bugs in an infested field. One specimen ate ten chinch-bugs in forty-eight days, another eight during the same period, while a third only ate five in forty-two days. Only chinch-bugs in the later stage of growth were eaten.

The small striped ground beetle, *Agonoderus pallipes,* is very common in all grain fields in the central and southern part of Illinois but was never seen to attack living chinch-bugs in the field. In the insectary experiments with this species one beetle under observation for fifty-five days ate seven dead chinch-bugs but would not attack living bugs although confined with them for this entire period. Another specimen of the same insect kept under the same conditions for eighteen days ate one dead chinch-bug and one cast molt skin.

In the field larvæ of Coccinellids were frequently seen to feed upon chinch-bugs. Several attempts in the insectary to get the number of chinch-bugs eaten by the different species of these larvæ were without definite results. The Coccinellids were never contented in any of the several types of cages used and spent nearly the entire time trying to get out, all dying within a week. A few chinch-bugs were eaten by them however.

Experiments with a few other species of ground beetles found in the chinch-bug infested fields did not show that these insects fed upon chinch-bugs.

To try and get a definite idea of the abundance of the chinch-bug predators in the fields counts were made of the number of these insects occurring in a measured square yard of stubble in a number of fields in central Illinois during July. On the average enough predaceous insects of the above species were found to eat eleven chinch-bugs per

day per square yard, or about two million per day for a forty acre field; this estimate being based on the results of the above insectary feeding experiments where only chinch-bugs were offered as food.

In the above counts it should be kept in mind that certainly not over one-half and probably not over one-third of the *Blechrus* present were counted. This insect is very active and seeks to hide on the least disturbance and its small size renders it very hard to see. The same is also true of *Pagasa fusca*. While in this case the insect is somewhat larger it is even more easily alarmed. Even the numbers of predators shown in the above counts however would easily account for ten chinch-bugs per square yard per day.

Fifteen bunches of grass in a moderately infested cornfield were carefully examined and yielded four hundred fifty-four chinch-bugs, two ladybugs, three Reduviolus, five predatory flower bugs and five Chrysopa larvæ, or enough predatory species to account for at least twenty chinch-bugs per day.

During the entire month of August, 1915, examinations made in cornfields in west central Illinois showed the predatory flower bug often averaging five to six per stalk of corn and Chrysopa larvæ, nymphs and adults of *Reduviolus*, *Pagasa fusca* and adults of *Blechrus* abundant in all chinch-bug infested fields.

It seems probable from the abundance of these insects in the fields and the numbers of chinch-bugs known to be eaten by them that when after a period of abundance the chinch-bug increase is checked by adverse weather conditions, that these predatory species together with the egg parasite may keep them from causing damage for a number of years. During the season of 1917 with a wide area in Illinois dangerously infested with chinch-bugs no marked damage has been done partly because of the abundance of these predatory species in the fields. *Reduviolus* and *Pagasa fusca* have been unusually abundant in chinch-bug infested fields during the past summer.

A NEW SPECIES OF SCIARA BRED FROM RED CLOVER CROWNS

By F. W. Pettey, *Cornell University, Ithaca, New York*

Professor A. C. Burrill of Moscow, Idaho, has sent to the Department of Entomology of Cornell University, some specimens of a *Sciara* reared by him from red clover crowns. An account of the life history of the insect by Professor Burrill will follow this article. The species is apparently undescribed.

Sciara trifolii n. sp. Male. Length 1.2 mm. Head black; antennæ fuscous, over two-thirds the length of the body. Thorax; mesonotum piceous, shiny, pleuræ fuscous. Abdomen black, intermediate segments with anterior two-thirds fuscous, hairs pale yellow; hypopygium brown, near its base with a small median ventral lobe (Fig. 15, b) margined with about 8 setæ; clasper (Fig. 15, a) with an apical tooth, and with about 4 stout, subequal, scattered spines and with one proximad, longer, more slender spine along the inner margin. Coxæ and palpi luteous; trochanters black; tibiæ dull yellowish-brown; tarsi fuscous to black; hind tibia and tarsus about equal in length. Wings hyaline; veins brown, rather strongly marked; media and cubitus without setæ; petiole of cubitus less than one-half the length of the base of media; R_1 ends at least one-sixteenth of the wing length proximad of the forking of M; the base of R_s distad of the mid point between the humeral cross vein and the tip of R_1; M_2 ends distad of the termination of R_s. Twin Falls, Moscow, Idaho. October 3, 1917. Figures a and b are magnified 300 diameters.

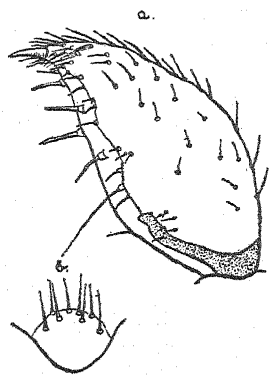


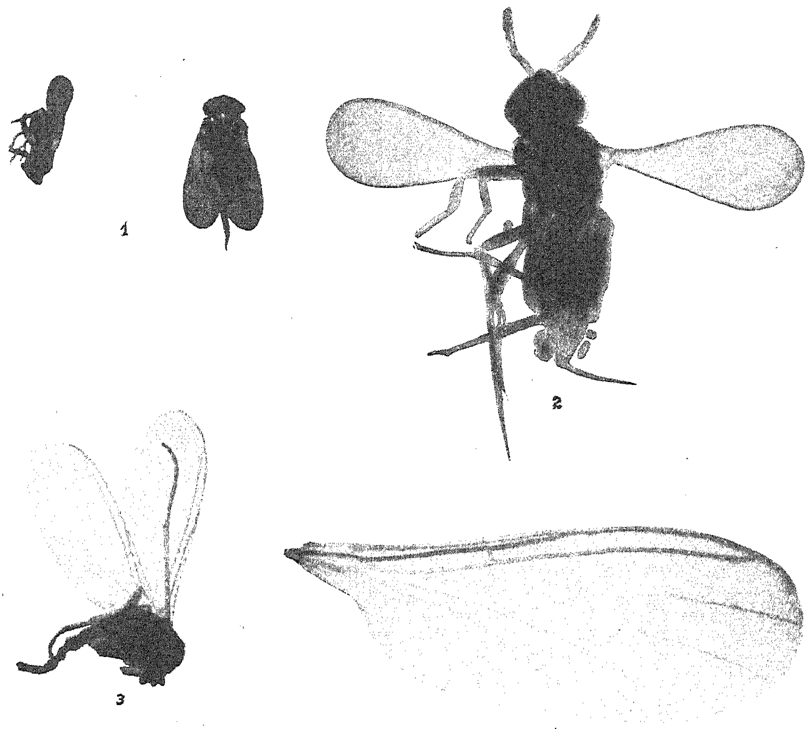
FIG. 15. *Sciara trifolii*, *a* clasper, *b* lobe of hypopygium (Original).

Female. Length 1.5 mm. Colored like the male. Moscow, Idaho. (See Pl. 13, Figs. 3 and 4 for wing venation.)

This species is closely related to *S. pauciseta* Felt, from which it may be distinguished by the characters of the hypopygium and the more retracted position of the tip of R_s.

Described from 2 males reared October 27, 1916 and October 3, 1916, and 10 females reared October 27, 1916, from the crowns of red clover, Moscow, Idaho.

Types in the Cornell University collection. Co-types in the Idaho Agricultural Experiment Station collection.



1. *Aphelinus lapisligni* How., dorsal and side views (21 diam. 440X).

2. Ditto, ventral view in balsam, wings and ovipositor extended (34 diam. or 1200X). Bred from *Aphis bakeri* Cowen.

3 *Sciara trifolii* Pett., wing of female (34 diam. or 1200X).

4. Ditto female in side view, balsam mount (21 diam. or 440X), a new species bred from red clover roots, Twin Falls, Id.

NEW ECONOMIC PESTS OF RED CLOVER[1]

By A. C. Burrill, *Entomologist, Moscow, Idaho*

The third successive epidemic of the clover aphis (*Aphis bakeri* Cowen)[2] in Idaho in 1916 reduced considerably the seed yield in red clover, and also in white and alsike clovers. In one 40-acre irrigated field, which should have gone 10 bushels (some go 15 bushels) to the acre, the yield was 5 bushels to the acre, a loss of over $1,600. The average condition on some 60,000 acres throughout the State is estimated thus:

	Yield in Bushels per Acre			
Variety of Clover[3]	1914	1915	1916	1917
Red	8	6	2–4	4–5
Alsike	7	7	6	?
White	6	6	6	6

In 1917, a January zero spell following after excessive numbers of aphis enemies, seems to have released the 1917 crop from excessive damage.

Where the clover heads are very sticky from aphis, preliminary thorough drying is necessary before the seed will thresh. Usually the heat of the threshing melts the crystallized honeydew so that whole sacks may cake nearly solid. This phenomenon is also seen in the heap of weed seed sifted from the thresher separator. On first test, this sticky seed germinates better than well-dried unaffected seed. Idaho produces the best colored seed in the world and the best in price and yield per acre. Clover is no doubt the key crop in rotation with war wheat, and its enemies are thus of present importance.

The enemies of this aphis are very numerous but their ability to check the epidemic seems to be nil until the third or fourth week in August, when the crop damage is almost complete. By that time the chaff and stems gather on the cutter blade of the mower, making delays for frequent cleaning advisable. The larval Coccinellids in the fields in August have bred out mostly *Hippodamia 5-signata* Kirby, *H. convergens* Guerin, *H. lecontei* Muls., and *Coccinella trifasciata* L., but they and their adults appear to be unable to penetrate all parts of the clover head to destroy every last aphis. And thus, a head may come to have as high as 300 aphids before enemies gain the upper hand,

[1] Published with the permission of the Director (J. S. Jones) Idaho Agr. Expt. Station. First presented as a paper at the Dec., 1916, meeting of the Am. Assn. of Econ. Entom., New York, N. Y., under the title "Insects of the Year in Idaho"; publication delayed for specific determinations.

[2] J. J. Davis, det.

[3] Id. A. E. S. Bul. No. 100. Clover Seed Production. L. C. Aicher. June, 1917.

a rate of infestation twice as great as the number of seeds produced by a normal head. In some fields where such heavily infested heads occur, the pedestrian will get his trouser legs very sticky on a level with the excessively sticky clover blossoms. Adjoining clover fields which have been cut at a slightly different time will have so few aphids or honeydew, that much destruction of the aphis evidently follows from the curing of the hay in the sun.

The most abundant Syrphid flies have been reared and await determination. Far more numerous than these are the new species of Hymenopterous parasites (*Aphelinus lapisligni* How.) discovered independently by Mr. L. R. Rockwood and myself, mine having been first considered by Dr. Howard as either a different variety or a still different species.[1] (See Pl. 13, figs. 1 and 2.) Seldom more than ten of this parasite occur per head of clover, and the parasitized jet black aphids appear more often in the lower leaf petiole bracts sheathing the stem than in the head, indicating an earlier attack of the parasites, before the clover blossom heads form. This also indicates that on some plants, the aphis infestation proceeds perhaps from apterous female aphids overwintering next the crown.

Quite as numerous in some fields are the orange-yellow nymphs of the Western Dark Triphleps (*T. tristicolor* White), averaging from one to three individuals per clover head. These rapidly and more persistently penetrate all parts of the clover bloom and stem than all the other aphis enemies combined.

Preliminary tests with orchard sprayers driven through the fields have shown that a majority of the aphids may be destroyed with nicotine sulfate and soap at usual strengths. We had thought to chronicle the discovery that Syrphid larvæ and Triphleps nymphs, together with the adults of Syrphids, Coccinellids, Triphleps, and honey bees are little affected by this spray, appearing to be as lively as ever two to three days after application. However, in Maine Bulletin No. 253, p. 221, Metcalf has laboratory proof of the survival of Syrphid larvæ so sprayed. I have since found that where adult *H. convergens* are confined in small capsules of sprayed leaves, they die. After the spraying, natural enemies gain the upper hand.

Sodium arsenite sprayed by orchard or field sprayers (formula based on that in Wisconsin—J. G. Sanders) has proved 99 per cent efficient against grasshoppers in many alfalfa and clover fields of all ages of growth; and the addition of nicotine for aphis does not make it burn worse. Over 20,000 acres were sprayed with arsenite, I was told, under the direction of the County Agents in 1916, but too much burn-

[1] Howard, L. O. Proc. Biol. Soc. Wash., Mar. 31, 1917. Vol. 30: 77–8; personal correspondence.

ing resulted in some cases. Insistent demands of beekeepers that these sprays may kill off their bees, are hard to set at rest until a long series of toxicity tests in the honey bee has been followed out in line with the excellent Federal contributions.[1]

The part which thrips play, the red or black species (*Haplothrips statices* (Haliday), syn. *Phlaeothrips niger* Osb.[2]) in the clover and alfalfa seed loss is not understood. In July, 1917, Mr. A. H. Harrison and I watched under a hand lens how these species scarify the floret envelopes of clover blooms towards the floret bases.

Frequent requests for data about mites on clover crowns, also on potatoes, dying tree trunks, etc., failed to bring to light any one species as primarily to blame, other than that *Rhizoglyphus rhizophagus* Banks[3] is most common, some immature gamasids of the Uropodidae and *Hologamasus inarmatus* n. sp.[2] The widespread death of red clover crowns after cutting the seed crop infested with aphis, has been blamed to *Aphis bakeri* Cowen, but recent rearings from infested crowns in the same area, of numbers of a new species of Sciara (*S. trifolii* Pett. near *S. varians*[4] indicate other contributory causes. The mites befouled other tests as follows:

Received red clover roots swarming with black-headed, white maggots and white mites, September 30, 1916 from field 4m. NW of Twin Falls, Idaho, with a note to the effect that whole fields of clover were dying, following the clover aphis epidemic in August and cutting the seed crop about September 1. Ewing determined the mite as *R. rhizophagus* and adults from maggot are described above as the Mycetophilid, *Sciara trifolii* Pett. Under careful watering, the supposed dying clover crown was revived so as to send out new sprouts and insects were reared as follows:

October 3, one adult had emerged.

October 23, 1916, first dozen adults appeared; last one died November 11.

November 23, 1916, second brood adults appeared; last one died November 30.

December 24, 1916,[5] third brood adults appeared; last one died January 8.

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[1] N. E. McIndoo. Sense Organs, etc., Honey Bee. Smiths. Misc. Coll. Publ. No. 2381: McIndoo. Effects of Nicotine as an Insecticide. Jour. Ag. Res., Oct., 1916. Cf. C. W. Mally, arsenicals did not hurt bees. Agr. Jour. Union of So. Afr., June, 1909.

[2] J. D. Hood, det. in letter, Feb. 25, 1918.

[3] H. E. Ewing, det.

[4] Through courtesy of Prof. O. A. Johannsen, described in preceding note by F. W. Pettey, Cornell Univ.

[5] Figs. 3 and 4 are made from female of Brood III presumably.

February 4, 1917, fourth brood adults appeared; last one died March 10. Meantime, mites swarmed on root and stem, and the plant soon wilted beyond revival. It seemed to be impossible to get any clover material started for tests without having it fouled by the above mite sp.

August 31, 1916, another sending of dying red clover crowns from the Twin Falls South Side tract yielded the same mite and a new species, *Hologamasus inarmatus* Ew. Although coaxing this clover crown into growth, it soon wilted under the mite attack presumably, no maggots being present. A heavy teaching schedule prevented detailed life-history work, but Sciarid larvæ have been preserved in balsam. If by chance *R. rhizophagus* is found to have habits as notorious as the bulb mite, *R. hyacinthus* Boisd., clover in irrigated sections will need further study.

An unexpected setback overtook operations by growers in spraying nicotine and soap for bean thrips (*Heliothrips fasciatus* Perg.). At the usual strength and put on with an orchard power sprayer, this insecticide failed to wet a large part of the infestation. A visit later showed that a concurrent attack of red spider mite (*Tetranychus telarius* L.) had so webbed the leaves as to protect large numbers of thrips from a wetting. Large losses in beans from this epidemic occurred throughout Idaho in 1916 but not in the backward season of 1917. Field crop losses in Idaho run into the millions annually, and though figures have been compiled, I hesitate to give them.

EXPERIMENTS ON COCKROACH CONTROL

By E. V. Walter, *Ames, Iowa*

Poison and traps of various kinds have long been used for cockroach control. At best traps cannot be relied upon as a means of extermination, since they only alleviate conditions. Certain proprietary roach poisons on the market have given good results but these are all high in price. Moreover cockroaches are so wary that, when a few have been poisoned, others will not feed unless starved to it.

The material for this article is taken from notes by the writer while employed as an assistant in the Entomology Section, Iowa Agricultural Experiment Station, in the summer of 1917. The work was undertaken at the suggestion of R. L. Webster when the manager of a local cafeteria called for assistance in controlling cockroaches.

J. A. Lintner[1] seems to be the first writer to tell of the use of borax

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[1] Injurious Insects of New York. First Report, 1882, p. 343.

and mentions having killed many roaches with this material. Since that time powdered borax and powdered sugar, mixed in equal parts, have often been recommended, possibly more than any other materials, since these are nonpoisonous to human beings. Powdered borax and powdered sugar were first used at the cafeteria but gave no relief and no dead roaches were observed after using.

Traps were used at the same time as the borax. These were made by inserting a paper cone, tipped with hair, into a flat bottom flask. The flask was laid on its side, using banana peeling as bait within. This differs from the Graham roach trap described by Washburn,[1] since it has only a single cone with a row of bristles at the small end. The Graham trap has a double cone with bristles on the small end of the inner cone.

Two traps were placed beneath the steam-heated serving table in the cafeteria. Trap No. 1 was in a place where diffused light from a window would strike it by day and indirect artificial light would strike it in the early part of the night. Trap No. 2 was in the dark day and night. Other conditions, so far as observed, were equal. Collections were made from the traps at ten o'clock each morning. The hair on the cones did not entirely prevent the escape of the roaches and, as they avoid light, the wide difference in results may be partly explained in this way. Most of the roaches caught here were *Blatella germanica* although *Blatta orientalis* seemed to be fully as abundant in the building.

Table No. 1. Cockroach Traps in Cafeteria

	Trap No. 1 (In light)		Trap No. 2 (In dark)	
Date	Adults	Nymphs	Adults	Nymphs
June 9	3	1	1	28
June 10–11	0	0	7	108
June 12	0	4	3	96
June 13	4	18	15	133
June 14	0	26	3	111
June 15	0	49	7	87
June 16	0	18	1	63
June 17–18	0	203	4	279
June 19	1	39	2	167
June 20	0	15	1	100
June 21	0	32	0	331
13 days	8	405	44	1,503

While the traps were being used a new manager took charge of the cafeteria. When he saw conditions this new manager wrote to an agent of a roach poison company who guaranteed to rid the place entirely in thirty days. Arrangements were made for the employment

[1] Journal of Economic Entomology, vol. 6, p. 327, 1913.

of this agent, who used a white powder, scattering this every place that the cockroaches frequented. This agent would not tell what the powder contained, nor would he sell it, insisting on doing the work himself. The next morning after the powder was scattered on the shelves, floor and in all corners, the floor was literally covered with dead and dying roaches and within a week's time scarcely any could be found, a few days later none at all. Very few roaches were found several weeks later but these may have come in afterwards. The writer scraped up some of this powder and turned it over to Dr. S. B. Kuzirian of the Chemical Section of the experiment station for analysis. His report shows that powdered boric acid was the only thing found.

August 22 a mixture of powdered borax and powdered sugar was again tried in the kitchen of a sorority house. After three days no dead roaches could be found, although they were seen in the mixture and under papers where it was scattered. On August 25 this mixture was removed and powdered boric acid scattered on the shelves and floor. The next morning a number of dead roaches were seen and at the end of ten days only one live roach could be found. None at all were observed on later visits. Boric acid was again tried in the dispensary room of the bacteriology department of the college, with even better success. After four days only one roach could be found and none on later visits.

At another time boric acid was tried on a larger scale in a large grocery store and basement. Although the work here was not done thoroughly enough to completely rid the place of roaches, yet their numbers were greatly reduced. So quickly and effectively did the boric acid work that twenty dead and dying roaches were picked up behind one fifteen foot counter half an hour after it was placed there.

These tests showed the effectiveness of boric acid. Further trials were made to determine how the roaches obtained the material and also to determine further if powdered borax and powdered sugar would not work as effectively. More roaches were trapped and confined in battery jars in the insectary in making further trials.

On one occasion after boric acid had been used at the sorority house one healthy roach and one nearly dead were picked up and placed in the same jar. They were given no food and left undisturbed. One died later in the day but was not removed. Three days later the remaining healthy roach ate the stomach and intestine of the dead one and died in a short time.

This showed that cockroaches ate the boric acid and that, after killing one individual, the boric acid might still be fatal to others. To test this point further five roaches, recently killed with boric acid, were thoroughly washed and the stomach and intestines removed and

placed in a battery jar with six healthy roaches. Within four days all of the intestines had been eaten and four roaches had died. The two remaining were not affected, although retained in the jar fully a week longer.

From this work it was seen that boric acid readily killed cockroaches upon eating it. Would they eat it more readily if mixed with powdered sugar? In another experiment eighteen roaches were placed in each of two battery jars and the powder placed at one side of the jar. No difference was observed in the effectiveness of boric acid used alone or mixed with sugar. The roaches were placed in the cages at 5.00 p. m. September 12 and by noon September 14 all were dead in both jars.

TABLE NO. 2. BORIC ACID ALONE COMPARED WITH BORIC ACID AND POWDERED SUGAR.

	Boric acid alone	Boric acid and powdered sugar
Sept. 12, 5 p. m.	Experiment started	
Sept. 13, 8 a. m.	7 dead	7 dead
12 noon	5 dead	3 dead
4 p. m.	1 dead	2 dead
Sept. 14, 8 a. m.	4 dead	5 dead
12 noon	1 dead	1 dead
	—	—
Total	18 dead	18 dead

Up to this time the powdered borax and powdered sugar mixture had been used by the writer only in the open and apparently without success. Thirty roaches were now placed in each of two jars. Borax and sugar were placed in one, boric acid in the other, each at one side of the jar. This was to determine whether the borax mixture would kill the roaches and also to determine the length of time required to kill all the roaches in each case. In this experiment all the roaches in the cage with the boric acid were dead after four days, while it required thirteen days to kill all of them with the borax. Sixteen roaches in the cage with the borax were dead at the end of four days. The sugar caused the mixture to become more compact, evidently retarding its action. No other food was given in either cage.

A few days later the same experiment was repeated using thirty roaches in each cage as before, this time introducing a banana peeling, of which roaches are very fond, into each of the two cages. The powder was placed in a watch glass so that the roaches had free access to it, but need not necessarily get into it. In this case the boric acid killed all roaches in four days, while it took fourteen days to kill them with the borax. Dr. Geo. D. Shafer[1] has shown that borax also acts as a

[1] Technical Bulletin No. 21, Mich. Agr. Coll. Exp. Station, p. 54, 1915.

contact insecticide killing the roaches in two to ten days through contact of the powder alone.

TABLE No. 3. BORIC ACID AND BORAX AND SUGAR COMPARED

	Without other food		With other food	
Date	Boric acid	Borax and sugar	Boric acid	Borax and sugar
Sept. 13		Exp't started		
Sept. 14		0 dead		
Sept. 15		2 dead		
Sept. 16		14 dead		
Sept. 17		3 dead		
Sept. 18		4 dead		
Sept. 19		0 dead		Exp't started
Sept. 20		0 dead[1]		0 dead
Sept. 21		1 dead		3 dead
Sept. 22		3 dead		5 dead
Sept. 23		1 dead		6 dead
Sept. 24		1 dead		3 dead
Sept. 25	Exp't started	1 dead	Exp't started	0 dead
Sept. 26	2 dead	Total 30	2 dead	0 dead
Sept. 27	13 dead		19 dead	0 dead[1]
Sept. 28	12 dead		9 dead	6 dead
Sept. 29	3 dead		Total 30	1 dead
Sept. 30	Total 30			0 dead
Oct. 1				0 dead[1]
Oct. 2				6 dead
Oct. 3				Total 30

At another time pieces of apple spread with borax were placed in a cage containing 126 roaches that had been without food for twenty-four hours. This was to determine the length of time required to kill the roaches when they were forced to eat borax in order to obtain other food. In this case eight days were required to kill all the roaches, although most of them were dead within the first four days.

TABLE No. 4. BORAX SPREAD ON APPLE

Date	No. of roaches dead and removed
Sept. 20	Experiment started
Sept. 21	14
Sept. 22	57
Sept. 23	29
Sept. 24	20
Sept. 25	4
Sept. 26	1
Sept. 27	0
Sept. 28	1
Total 8 days	126 roaches

[1] On these dates the borax and sugar mixture was stirred up in order to freshen it. Apparently this made it more effective for more dead roaches were found soon after.

The habit of extreme personal cleanliness was observed shortly after the work was begun with roaches confined in cages. This interesting habit, also observed and recorded by Dr. L. O. Howard[1] and Dr. Geo. D. Shafer[2] throws a great deal of light on the reason for roaches eating boric acid.

A cockroach covered with dust or dirt will, when unmolested, begin a process of cleaning. Usually it draws first one antenna after the other slowly between the mandibles, then begins on the legs, later the abdomen, doubling up almost into a ball until it cleans itself thoroughly. Boric acid being a very fine, light powder, readily adheres to the roach and must be cleaned off. The powdered borax and powdered sugar mixture is heavier, and readily hardens if moisture is present, so does not stick as well. The writer has never observed roaches eating either the borax and sugar mixture or boric acid except in their efforts at cleanliness. Boric acid has no effect on the eggs already deposited so unless the powder is left on the shelves for a considerable time, treatment must be repeated after a few weeks.

Prices for boric acid vary greatly at the local drug stores. This year (1917) it was purchased at 30 cents per pound. The New York wholesale market report for November 20, 1917[3] gave the price of powdered boric acid at 13½ cents per pound. Sodium fluorid, which is also used to kill roaches, is quoted in the same Journal at 18 to 19 cents. Sodium fluorid was much higher in price than boric acid so was not used in this work.

Summary

1. Traps may be used as means of control but cannot be relied on as a method of extermination.

2. Boric acid is a safe and economical material to use against the roaches as it is nonpoisonous to human beings and yet very effective against roaches.

3. A mixture of equal parts of powdered borax and powdered sugar ground together is effective against cockroaches, is safe and economical, although acting slower than boric acid.

4. Cockroaches eat these substances in an effort to keep clean and not for any possible food value.

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[1] The Insect Book, p. 331, 1902.

[2] Technical Bulletin No. 21, Mich. Agr. Coll. Exp. Station, p. 55, 1915.

[3] Journal of Industrial and Engineering Chemistry, December, 1917.

NOTES ON A NEW MITE ATTACKING VALLEY COTTONWOOD

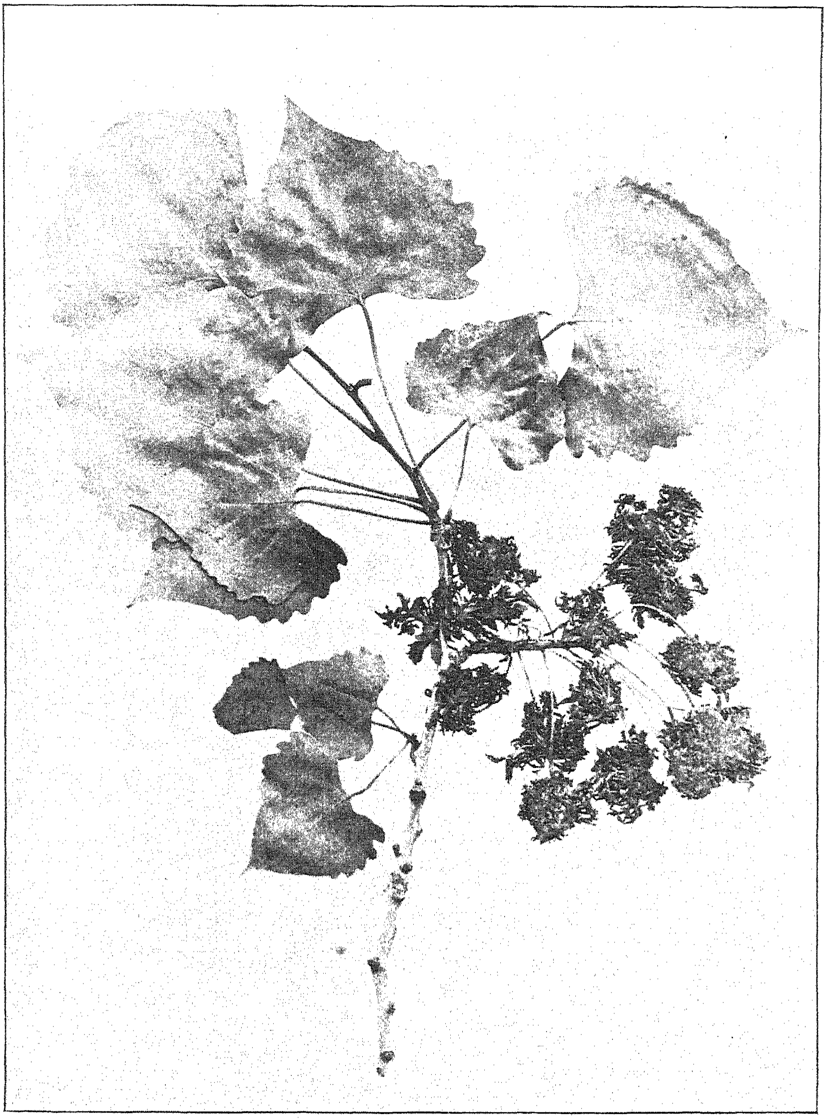
By P. J. O'Gara, *Director, Department of Agriculture and Smelter By-Products Investigations, American Smelting & Refining Co., Salt Lake City, Utah*

On May 12th of this year while examining some poplar trees (*Populus wislizeni* S. Wats. Sarg.) near El Paso, Texas, a very interesting infestation of mites was noted on the current year's growth.

On the accompanying photograph, Plate 14, the normal foliage of the tree is shown at the top, while below is shown the work of the mite. Here the leaves which should have normally grown at the ends of the petioles have been very much dwarfed and cut. The general appearance is very much like a dense inflorescence such as one would see in plants which produce a large number of floral elements. The photograph so well illustrates the appearance of the infestation that an extended description is not deemed necessary.

Examination of the affected leaves revealed a very small mite, measuring approximately one-tenth of a millimeter long, its width being about one-fourth of its length. Specimens were sent to Dr. L. O. Howard of the United States Bureau of Entomology with the following note: "The Pathologic condition of the specimen indicates to me an infestation of some species of mite, perhaps an *Eriophyes*."

Dr. Howard referred the specimen to Prof. P. J. Parrott, who reports, through his assistant Mr. H. E. Hodgkiss, that the mite is a new species of *Eriophyes* which has not been heretofore described. He also indicates that the type of injury produced by the mite is new.



Work of eriophyes sp. on valley cottonwood (original)

Scientific Notes

European Potato Wart Disease. Recent advices report the discovery of this disease in ten small mining villages near Hazleton, Pa. The Pennsylvania Inspection Service is coöperating with the Federal Horticultural Board in handling the situation. The Pennsylvania horticultural law gives adequate quarantine power.

Lopidea media, a persistent pest of phlox. For a number of years the writer has noticed the phlox plants of certain gardens of Fayetteville, Ark., to be infested by a Capsid which Mr. Chittenden has determined for us as *Lopidea media.* The insect seems to occur only in certain gardens but in these gardens it is a very persistent pest and makes its appearance every year. This bug causes the tender tips and the leaves of infested plants to curl, and the plants take on a sickly yellowish-green appearance. In some gardens phlox growing has been abandoned because of the bug. In 1917 adults of the first generation were found by May 5 though most of the bugs were still in their nymphal stages by this time. It would seem that there must be at least three generations a year in this latitude.

Geo. G. Becker,
Agricultural Experiment Station, Fayetteville, Ark.

Cannibalism in Euetheola rugiceps Lec.? In some material which was sent the writer from Newport, Ark., in 1915 one beetle was observed to have been partly devoured by another. The partly devoured beetle had one of its elytra eaten off and when it came to the writer's attention, it consisted of nothing but a hollowed-out, chitinized shell. A beetle had its head deeply buried in the back of the dead specimen, and was apparently feeding very ravenously as it was separated from the dead specimen with difficulty. Whether the partly devoured beetle died en route and was subsequently attacked or whether it was attacked while alive cannot be determined.

Geo. G. Becker,
Agricultural Experiment Station, Fayetteville, Ark.

A Second Food Plant for the Cherry Leaf-Beetle. In the recent economic literature pertaining to the Cherry Leaf-Beetle, *Galerucella cavicollis* LeC. such as the following:

"Observations on the Life-History of the Cherry Leaf-Beetle," by Glenn W. Herrick and Robert Matheson, in Journ. Agr. Research, Vol. V, No. 20, Feb. 14, 1916, pp. 943–950, and

"The Cherry Leaf-Beetle," by F. Z. Hartzell, Bull. No. 444 (Dec., 1917), N. Y. Agr. Expt. Station, Geneva, N. Y., statements are made that so far as known, the only native food plant of this beetle is the pin cherry, *Prunus pennsylvanica* L. I can add a second. While collecting in the Black Mountains of North Carolina, in July, 1902, I found this beetle feeding in numbers on the leaves of the fire azalea, *Rhododendron calendulaceum* (Mich.) G. Don., and though wild cherry, presumably the pin cherry, was found in the neighborhood, did not take it upon that. While at Ithaca, N. Y., during the summer of 1917, I took this beetle in great numbers from the pin cherry and also found it again feeding on the leaves of a species of azalea. The azaleas were not in the neighborhood of any wild cherry trees that I could see.

Edwin C. Van Dyke,
Berkeley, Cal., Sept. 3, 1918.

The European Earwig. Mr. Essig's recent note (p. 338) leads me to record that I found a living specimen of *Forficula auricularia* while unpacking tulip bulbs received in Boulder direct from Holland.

T. D. A. Cockerell.

Apple Tent Caterpillar. In the Seventeenth Report of the State Entomologist of Connecticut (p. 363) reference is made to the practical disappearance of the apple tent-caterpillar (*Malacosoma americana* Fabr.) in many localities of that state in 1917. In describing a reason for this marked decrease after several years of great abundance the following statement is made:—"The reason for its disappearance cannot be explained here, but is probably the effect of parasites or other natural enemies." The writer has also noted a similar phenomenon in several regions of New York but has ascribed it to entirely different causes.

In the vicinity of Syracuse numerous colonies of recently hatched apple tent-caterpillars were found during the last week in April following a week of mild spring weather. This week of spring weather was followed by five weeks of extraordinarily cool weather. Field notes made May 26 record very unexpected observations regarding the brood of the tent-caterpillar. Several trees of the wild cherry which for the preceding three years had been entirely stripped of their first crop of leaves, were observed to show no signs of defoliation. When a more careful examination was made, colony after colony of tent-caterpillars were found entirely exterminated, the small tents being occupied by the dead bodies of the minute recently hatched larvæ. In a few of the nests were found from one to five living caterpillars a half inch or more in length, the dead larvæ which comprised the remainder of the colony being less than a quarter of an inch long. According to a rough estimate made at the time, less than one per cent of the larvæ had survived. It is likely that the ultimate survivers represent a much smaller per cent when it is taken into consideration that this species is so dependent upon their tent for protection from inclement weather conditions, and that the few survivers of a colony would probably be unable to construct an adequate shelter.

The explanation which at the time we believed accounted for the extraordinary mortality among the larvæ was the unusual weather conditions of the spring of 1917. A recent examination of the temperature records for April and May[1] of that year strengthen our belief in the validity of this conclusion. During the five-day period from April 18 to April 22 the maximum temperature each day at Syracuse varied from 66° to 71° and the minimum daily temperature varied from 42° to 51°. It was during this period that the eggs of the tent-caterpillar hatched. During the succeeding period of 26 days (April 23 to May 18) there was only one day (April 29) in which the maximum temperature was above 60° and only four on which it was above 55°. During the entire month of May the mean temperature for the entire state was 48.2° or an average deficiency of 8°. It is likely that the deficiency at Syracuse was even greater than 8° for the period from April 23 to May 18.

During this period the buds of the wild cherry which had begun to open in April ceased developing and the prevailing low temperature and frequent rainfall (there being only 7 days in the 26-day period when there was no precipitation) prevented the caterpillars from feeding so that most of them were killed by starvation before the return of normal conditions. That the death of the larvæ was not due to parasitic or predaceous enemies was evidenced by their size (less than ¼ of an inch) and by the

[1] Climatological Data, New York Section for April and May, 1917, U. S. Dept. Agri., Weather Bureau.

fact that their bodies were unmutilated and their newly started tents were uninjured. It would be interesting to know of other cases where the numbers of certain species of insects have been so directly influenced by weather conditions.

M. W. Blackman,
Professor of Forest Entomology,
The New York State College of Forestry, Syracuse, New York.

Blossom Spraying and Bee Poisoning. Literature on the subject of poisoning bees with lead arsenate in a blossom spray appears strongly in favor of this notion; however in spite of this enlightening influence we find many practical beekeepers and more orchardmen in a doubtful frame of mind regarding the effect on bees of a poison spray at blossom time. In some instances growers vigorously contend that bees are not killed by an arsenic spray applied at this time. Conclusions in these instances are drawn from field observation only, and the habits of the bee make these alone very unsatisfactory.

With a view of clearing up this situation experiments have been undertaken. These are calculated to cover a period of two years, and designed in such a way as to meet the field as well as the laboratory requirements. In planning the outside work special precaution was taken to get actual field conditions which would permit and facilitate the keeping of records on the individual colonies.

The laboratory program consists chiefly of work in analysis of bees and the feeding of individuals known amounts of arsenic to determine a deadly dose. The latter has been finished and it is interesting to note that less than .0000005 gram of arsenic (As_2O_3) proves fatal.

A part of the work is completed and the results obtained seem to indicate that bees may be killed by a poison spray at blossom time. This work will be continued another year after which time a bulletin will be published giving a detailed account of the experiment and results obtained.

James Troop,
Department of Entomology, Purdue University, Lafayette, Indiana.

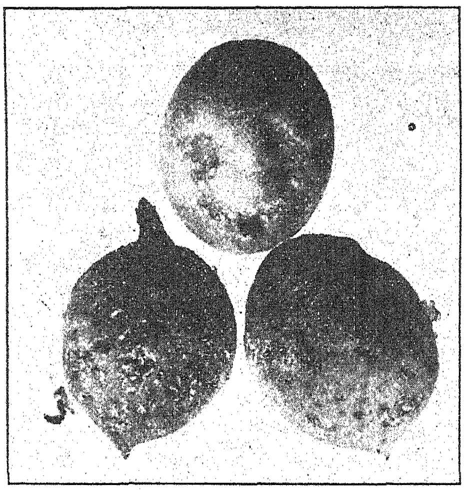
An Outbreak of Field Crickets. One of the field crickets, *Gryllus integer*, became so abundant during May and June, 1917, as to cause severe injury in the southern part of the Sacramento Valley (California). This insect is the common field cricket of the locality but has never before caused serious trouble in this vicinity, its usual status being that of a widely distributed species present at all times, but only in small numbers. The winter of 1916–17 was an unusually dry one, the months of February, March and April being characterized by slight rainfalls and with a temperature slightly above normal; these climatic conditions probably contributed to the development of such great numbers. Reports of their attacks on truck crops began coming in during April and by the first of May they were swarming in the grain, migrating continuously back and forth across roads or other intervening spaces in such numbers that the ground seemed alive with them. On one road near the Sacramento River a flock of terns was seen feasting upon them and so thorough was their work that not a cricket was to be seen where they had fed while in front of them there was at least one cricket to every square foot of ground.

The greatest damage which they caused was in newly set vineyards and orchards. New growth on both vines and trees was eaten off to the trunk and even the buds gnawed out to solid wood. Where the attack was prolonged death usually resulted, although in some instances sprouts from the crown kept the plant alive but this meant a loss of the previous years' growth.

The common formula for grasshopper bait (bran and arsenic) was tried but gave little protection. The most successful method of control was flooding the orchard or vineyard for a few hours. This would usually drive them out into grass land or the roadside for a few days at least and give the young planting an opportunity to recover. By the first of June the crickets had disappeared so completely that it was with difficulty a single specimen could be found.

E. Ralph De Ong.

Thrips Injuring Peaches. Five or six years ago peach growers in the vicinity of Benton Harbor reported the presence of something producing blemishes on fancy peaches. The injury consisted of shallow, gummed scars on the fruit, little more than skin deep—injury that does not interfere with the quality to any extent, but



which places what would otherwise be a fancy peach, in the second class or lower because of its appearance. The cause of this injury was obscure and was only made known after a trip by Mr. G. C. Woodin, at that time an assistant in this department, who managed to get to the orchard at the right time, just after the fruit set and while the little peaches were growing rapidly. On many of these peaches one would find patches of slightly discolored fuzz, which, when stirred with a needle were found to be practically eaten off or shriveled close to the skin of the fruit. In these patches were many miniature thrips which disappeared into the standing fuzz when disturbed. Such patches showed the skin to be abraded somewhat, but the surfaces healed and were covered with gum soon afterward, resulting in blemishes. The work of plum curculio was to be seen on the same fruit from time to time, and curculio eggs were to be seen sometimes in the denuded patches, although the work of the thrips is not characteristic of the curculio.

The damage by the thrips seems to be all done before the pits begin to harden and, therefore, before thinning time, which is fortunate because it makes it possible to eliminate many of the blemished fruits during thinning.

It is interesting to note that the injury seems to be most severe in the highest, driest, and warmest parts of the orchards and during seasons having hot, dry springs.

During June of 1917 Mr. P. B. Wiltberger, an assistant in this department, suc-

ceeded in collecting a quantity of the adult thrips which were submitted to Dr. W. E. Hinds of Auburn, Alabama, who pronounced them to be *Euthrips tritici* (Fitch), whose habit of working in strawberries is well known.

Since finding the blemished fruit in our western fruit belt, the writer has observed similarly blemished fruit in various stores in other parts of the state where peaches were offered for sale.

R. H. Pettit,
Entomologist of Experiment Station, Michigan Agricultural College, East Lansing, Michigan.

THIRTY-FIRST ANNUAL MEETING, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Baltimore, Md.—December 30–31, 1918

The Thirty-first Annual Meeting of this Association will be held in Baltimore, Md., December 30 and 31, 1918. Owing to war conditions it has been thought best to arrange a program which will give particular prominence to the insect problems that are vital in connection with war activities.

Members are requested to forward titles of the papers which they wish to present, and to submit subjects which are of special importance in connection with winning the war. New discoveries or information which has recently been secured along these lines should be presented for consideration at the meeting.

In order that the program can be completed, so that it can be printed in the December issue of the Journal, it is necessary that all titles of papers be in the hands of the secretary not later than November 9, 1918.

Applications for membership may be secured from the secretary, or from the chairman of the committee on membership. It is especially desired that all applications be filled out, endorsed and placed in the hands of the chairman of that committee well in advance of the date of the meeting.

A. F. Burgess,
Secretary.

MEMBERSHIP COMMITTEE NOTICE

Precedent provides that active members desiring to nominate associate members for active membership shall file such nominations with the chairman of the membership committee prior to the annual meeting. Nominations must be accompanied by full information concerning the nominee's publications and other qualifications. Where possible, copies of the publications enumerated should accompany the application.

It is also earnestly requested that associate members send a list of their publications, or better the publications themselves, together with a list of papers by other authors with which they have been associated during the investigation, to the chairman of the membership committee, marking them "For membership committee" so that they may be available to the committee in considering promotions from associate to active membership. Copies of publications should be sent to each member of the committee when possible.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1918

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

Separates or reprints, if ordered when the manuscript is forwarded or the proof returned, will be supplied authors at the following rates:

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Free admission, exclusion and extermination are three distinct policies followed in this country in relation to foreign insect pests. The first is characteristic of the early days and is the rule now in some measure. One of the great difficulties with exclusion or rigid quarantine is that it does not exclude. The history of the past twenty-five years might lead one to believe that prohibition (we are not now considering the liquor problem) has resulted in more rather than fewer introductions, though before assenting to any such conclusion allowance must be made for the greatly improved and increased commercial activities during this period and now abridged in considerable measure. The fact is that no system of commercial quarantine absolutely prevents the introduction of insects, though it may greatly delay the establishment of many. Furthermore, a quarantine possible under present conditions might break under its own weight when the present war ceases and there follows a most extensive commerce between this country and at least certain European nations. This factor should be carefully weighed before great changes are made in our quarantine regulations. It is impossible to maintain a Chinese wall. We are an essential part of the world and as such must share the dangers as well as blessings of our position. The problem is to secure the maximum protection practicable with a minimum disturbance of international and interstate relations.

Extermination of insects is a device to offset ineffective exclusion and is applicable only where the infested area is limited or special conditions favor such an attempt. It is a comparatively recent policy and available experience by no means sharply defines its possibilities.

The State of Massachusetts attempted to exterminate the gipsy moth and failed and yet this insect has been eradicated in other sections of the county where there was considerable infested territory of a somewhat difficult nature. We are inclined to believe that the effort in Massachusetts was possible though not practicable. It might have been entirely feasible for the general government. Attempts are now being made to exterminate or greatly restrict the spread of free flying insects. These efforts have not progressed to the point where success is a foregone conclusion. It is characteristic of the times that propositions of this nature are being received with an optimism unknown in the earlier days. There are a number of cases where extermination, even were most drastic measures necessary, would have been cheaper than the cost of subsequent control. Should extermination be successful, the possibility of reëstablishment in a similar manner must not be overlooked. It is an excellent time to forecast probabilities and determine the most promising lines of effort.

Obituary

STUART C. VINAL

Mr. Stuart C. Vinal, assistant entomologist of the Massachusetts Experiment Station, died at Arlington, Mass., September 26, as the result of typhoid pneumonia following influenza. Mr. Vinal graduated at the Massachusetts Agricultural College in 1915 and continued his entomological work there for an advanced degree, receiving his M. S. in 1917. In September of that year he was appointed assistant entomologist at the Massachusetts Experiment Station, after which his time was mainly devoted to investigations on market garden insects. He was a young man of unusual ability and the work he accomplished was excellent in its quality. His three published papers are "Notes on the Life-History of *Marmara elotella* Busck," Journ. Econ. Ent., 10: 388; "The Greenhouse Red Spider Attacking Cucumbers and Methods for its Control," Bulletin No. 179, Mass. Exp. Sta., and "The European Corn Borer, *Pyrausta nubilalis* Hübner," Bulletin No. 178, Mass. Exp. Sta. Another paper, "A Morphological Study on the Respiratory System of the Carolina Locust" is awaiting publication. All of his time during the past year has been devoted to an investigation of the life-history of the European corn borer, and he had collected material on this for another bulletin to be published this fall. The material thus obtained will probably be combined with that collected by workers in the Bureau of Entomology, with whom he was coöperating at the time of his death.

HAROLD O. MARSH

Harold Oscar Marsh died September 10, 1918, at Chester, N. J., the place of his birth.

Mr. Marsh was born November 6, 1885. He was educated in the public schools at Chester and took a special course in entomology at the Kansas Agricultural College, Manhattan, Kansas, in 1914. Prior to his employment in the Federal Bureau of Entomology, he was engaged in special work under the direction of the State Entomologist of New Jersey, and later of the State Zoölogist of Pennsylvania at Harrisburg. He was first appointed in the Bureau of Entomology July 1, 1908, having served ten years as an entomological assistant in truck-crop insect investigations. In the Civil Service examination which he took in economic entomology he obtained the highest rating among quite a number of applicants. His first employment was in Washington, D. C.; later he was in charge of sugar-beet insect investigations at Rocky Ford, Colorado, and at times was also engaged in similar work on truck-crop pests at Brownsville, Texas, in California, and for a short time in Hawaii. His principal work was accomplished while in Colorado. He had recently retired from active work in the Bureau, in order to take charge of his farm in New Jersey, where he was employed as a collaborator, but he had planned to resume active work in the early spring.

Mr. Marsh was an enthusiast, an observer of unusual excellence and was particularly adept at life-history work, excelling especially in obtaining the various stages of an insect and determining the life cycle and generations. He was unusually skillful in mounting and preparing all specimens which came under his notice, and this attracted much favorable comment. He was also a careful experimenter and kept accurate records of all his work.

Personally, Mr. Marsh was well liked in the community where he worked and by others who knew him; he was always prompt, painstaking and earnest, working early and late whenever the occasion demanded. In spite of a heavy handicap, a frail physique and eye troubles, he succeeded in accomplishing a great deal of work. The following is a list of his principal publications:

Biologic and Economic Notes on the Yellow-Bear Caterpillar. Bul. 82, pt. V, Bur. Ent., U. S. Dept. Agr., Aug. 31, 1910.

Notes on a Colorado Ant (*Formica cinereorufibarbis* Forel). Bul. 64, pt. IX, Bur. Ent., U. S. Dept. Agr., Oct. 17, 1910.

Biologic Notes on Species of Diabrotica in Southern Texas. Bul. 82, pt. VI, Bur. Ent., U. S. Dept. Agr., Dec. 8, 1910.

Notes on the Oviposition of the Tarnished Plant-Bug (joint with F. H. Chittenden). Jour. Econ. Ent., Dec., 1910, pp. 477–479.

The Hawaiian Beet Webworm. Bul. 109, pt. III, Bur. Ent., U. S. Dept. Agr., Nov. 6, 1911.

Report of the Assistant Entomologist. Bienn. Rpt. Bd. Agr. & For., Hawaii, pp. 152–159, 1910 (1911).

Some Experiments on the Chrysanthemum Plant-Louse (*Macrosiphum solanifolii Osborni* Gillette). Bienn. Rpt. Bd. Agr. & For., Hawaii, pp. 160–172, 1910 (1911).

The Imported Cabbage Worm (joint with F. H. Chittenden). Bul. 109, pt. III, Bur. Ent., U. S. Dept. Agr., Apr. 5, 1912.

The Sugar-beet Webworm. Bul. 109, pt. VI, Bur. Ent., U. S. Dept. Agr., Sept. 16, 1912.

The Horse-radish Webworm. Bul. 109, pt. VII, Bur. Ent., U. S. Dept. Agr., Jan. 30, 1913.

The Striped Beet Caterpillar. Bul. 127, pt. II, Bur. Ent., U. S. Dept. Agr., May 19, 1913.

Life-history of the Diamond-back Moth. Jour Agr. Research, U. S. Dept. Agr., July 2, 1917.

Notes on the Life Cycle of the Sugar-beet Webworm. Jour. Econ. Ent., Dec., 1917, pp. 543–544.

In addition to the list of publications above furnished, Mr. Marsh had contributed a considerable amount of work on other topics, including reports on the onion thrips in Colorado, on the larger beet leaf-beetle, on the false chinch-bug, on the bean leaf-beetle, and on the western cabbage flea-beetle.

F. H. C.

Current Notes

October, 1918

Mr. J. L. Horsfall has been appointed assistant in entomology at the Iowa College and Station.

Mr. R. H. Smith has been appointed entomologist of the Idaho Station vice A. C. Burrill, resigned.

Dr. Charles T. Brues has been promoted to be assistant professor of economic entomology in Harvard University.

The field laboratory of the Bureau of Entomology formerly located at Wellington, Kansas, has been removed to Wichita.

Surgeon-General William C. Gorgas accompanied Secretary Baker on his visit to the French battle front in September.

Mr. George Gilbertson, instructor in entomology at the South Dakota College and Station, is now in the military service.

Dr. L. O. Howard, chief of the Bureau of Entomology, during the summer, visited all of the field stations throughout the western states.

Professor E. R. King, assistant professor of entomology at Cornell University, has been commissioned second lieutenant in the Aviation Corps.

Mr. Dwight M. DeLong, of the office of the Pennsylvania Economic Zoölogist, has entered military service and is now at Camp Sherman, Ohio.

Mr. W. A. Thomas, assistant entomologist of the South Carolina Station and assistant professor of entomology in the College, has resigned.

Mr. W. D. Whitcomb, of the division of deciduous fruit insect investigations, Bureau of Entomology, has left the Bureau for Military Service.

Mr. Joseph L. King, of the office of the Pennsylvania Economic Zoölogist, has entered the Naval Reserves and is at Wissahickon Barracks, Cape May, N. J.

Mr. K. C. Sullivan has been appointed instructor in entomology at Missouri University and Station, and deputy inspector of nurseries vice A. H. Hollinger.

According to *Science* Mr. E. P. Van Duzee, curator of entomology, California Academy of Sciences, spent this summer in northern California collecting insects.

Mr. Herbert Spencer, formerly instructor in the department of zoölogy and entomology, North Carolina State College, had resigned to enter the Military Service.

Prof. Louis A. Stearns, department of biology, Alma College, Alma, Mich., has accepted a position as assistant entomologist of the Virginia State Crop Pest Commission.

Dr. W. L. Chandler, instructor in parasitology, Cornell University, has been appointed research associate in entomology at the Michigan Station vice Dr. G. D. Shafer.

Prof. P. W. Mason, assistant professor of entomology, Purdue University, has resigned to accept a position in the Bureau of Entomology, deciduous fruit insect investigations.

Mr. V. I. Safro is specializing as a fighting observer in the Aviation School at Mount Clemens, Mich., after having passed successfully in courses at Urbana, Ill., and at Dallas, Tex.

Mr. G. W. Underhill, formerly instructor in the department of zoölogy and entomology, North Carolina State College, has resigned to accept a position with the state entomologist of Virginia.

Dr. Gustavo Leonardi of the Royal Scuola di Agricoltura, Portici, Italy, the well-known Coccidologist and a foreign member of this association died in Ventimiglia, August 25, aged 49 years.

Mr. Thomas L. Guyton, formerly assistant entomologist of the Ohio Agricultural Experiment Station, is now a member of the staff of the Bureau of Zoölogy of the Pennsylvania State Department of Agriculture, Harrisburg, Pa.

According to the *Experiment Station Record*, the department of entomology of the New Jersey Station is making detailed maps of the area infested by the Japanese beetle, *Popilia japonica*, with a view to attempting its eradication.

Mr. C. H. Kennedy, a graduate of the Leland Stanford University and at present assistant in the department of entomology, Cornell University, has been appointed instructor in zoölogy and entomology at the North Carolina State College.

Dr. Burton N. Gates has resigned from the Massachusetts Agricultural College, Amherst, Mass., to accept a position as professor of apiculture in the Ontario Agricultural College, Guelph, Ont. Dr. Gates was married June 15 to Miss Carpenter of Amherst.

Prof. G. H. Lamson, Jr., of the Connecticut Agricultural College, Storrs, Conn., has been appointed a collaborator of the Bureau of Entomology, and will aid in devising methods for the control of insects in the trenches and around the military camps.

The following transfers have been made in the Bureau of Entomology: Dr. W. V. King has been placed in charge of the mosquito investigations at Mound, La.; A. P. Swallow to College Station, Tex.; H. O. Marsh, active service, Colo., to collaborator, Chester, N. J.

Mr. F. H. Lathrop, research assistant in the Department of Entomology, Oregon Agricultural College, has received a commission as second lieutenant in the Sanitary Corps of the army and was granted a leave of absence from the college for the duration of the war.

Mr. A. B. Black, a graduate of the college and temporary field specialist in the Bureau of Entomology, has been appointed assistant entomologist at the Oregon Agricultural College. His major problem will be a study of the control of the western peach and prune root borer.

Dr. Samuel Wendell Williston, professor of paleontology at the University of Chicago, died August 30, aged 66 years. Dr. Williston formerly paid much attention to a study of the Diptera, and published many papers including "Synopsis of the North American Syrphidæ" (Bulletin No. 31, U. S. National Museum) and "Manual of North American Diptera" which reached its third edition in 1908.

Mr. Lloyd R. Watson of the New York School of Agriculture at Alfred, N. Y., has been appointed to take charge of the new department of beekeeping at the Connecticut Agricultural College at Storrs, Conn. Mr. Watson will have charge of the College apiary, will give courses in beekeeping to the resident students and during the first year will probably devote the major portion of his time to extension work.

According to *Science* a bill (Senate bill No. 3344) has been introduced by Senator Weeks of Massachusetts to prohibit the entry into the United States except by the secretary of agriculture, of all nursery stock. Field, vegetable and flower seeds, bedding plants, and other herbaceous plants, bulbs and roots are exempt from its provisions, and any stock brought in by the secretary of agriculture must be held in quarantine for a sufficient period to establish its freedom from insect pests and plant diseases.

Resignations from the Bureau of Entomology are announced as follows: H. S. Saidel, C. H. Alden, D. A. Davis and A. D. Tilton to enter the army; R. S. Clute, Fla.; Ward H. Foster; E. F. Atwater; A. LeRoy Strand; R. B. Wilson; Perry W. Fattig, Fla.; Dr. O. H. Basseches, to become inspector in the Bureau of Animal Industry; H. E. Loomis and A. H. Jarrell to enter the navy; Marshal Hertig, Minn., A. H. Sherwood, S. D., H. L. Seamans, Mont., C. K. Fisher, Colo., J. S. Stanford, to enter the army.

The following appointments to the Bureau of Entomology have been announced; temporarily, tobacco insects, S. F. Grubbs, J. W. Hill, Scott C. Lyon, D. M. Rogers: cotton insects, Turner Davis, C. M. Brickwell; P. W. Mason, scientific assistant,

F. L. Wellman, C. I. Bliss, field assistants. Deciduous Fruit Insect Investigations: Dr. Norman Perrine, inspector, Federal Horticultural Board; Miss Ada F. Kneale, scientific assistant, Forest Insects; Geo. A. Hummer, extension apiculturist, Miss.; J. H. Morrison, Colo.; W. A. Thomas, N. C.; Geo. H. Vansell, S. C.; F. W. Humphrey, Tex.; Robert Fouts, Penn.; Mrs. Sibyl Swegman, artist; E. C. Davis, apiculture extension work, La.; Miss Edith M. Brace, scientific assistant, Washington, D. C.; temporary field assistants, D. C. Barney, J. J. Dickson, A. O. Hammett, A. G. Monette, J. W. Patterson, E. B. Smith, G. L. Smith, R. J. Smith, C. G. Wallace, A. L. Williamson, H. C. Young, Tallulah, La.; C. M. Barrett, C. P. Daley, L. N. Judah, J. T. Lewis, Jr., N. L. MacQueen, G. B. Pearson, A. L. Spencer, T. P. Weakley, Clarksville, Tenn.; S. H. Livingston, Mound, La.; Miss Mabel S. Stehle, scientific assistant, Washington, D. C.; M. V. Reed, collaborator, Atlanta, Ga.; Herbert J. Pack, Herbert F. Gates, Eastern, Mass.; Stewart Lockwood, N. D.

A conference regarding the European Corn Borer *Pyrausta nubilalis* Hbn. was held at the State House, Boston, Mass., September 6, 1918. All the New England States, New York and the Federal Bureau of Entomology were represented. This promises to be a very destructive pest and now infests an area about 15 X 25 miles in extent near Boston, but reaching mostly westward and northward of the city. There are two and possibly three generations each year, and the species is only slightly parasitized. Its attacks are not confined to corn, but at least sixteen different plants are eaten, including barnyard grass, dock, pigweed, bean, tomato, etc. Vermont and Connecticut have placed embargoes against corn on the ear and cornstalks from Massachusetts, and other states will probably follow suit and a Federal quarantine will probably be established soon. Those present were Dr. L. O. Howard, Washington, D. C.; Dr. E. P. Felt, Albany, N. Y.; Dr. H. T. Fernald, Amherst, Mass.; Prof. W. C. O'Kane, Durham, N. H.; Dr. W. E. Britton, New Haven, Conn.; Harold L. Bailey, Bradford, Vt.; Frank H. Dudley, Augusta, Me.; C. H. Batchelder, Orono, Me.; J. J. Pillsbury, Providence, R. I.; Prof. W. D. Hurd, Amherst, Mass.; S. C. Vinal, Amherst, Mass.; S. H. Gates, Arlington, Mass.; R. H. Allen, state nursery inspector, Boston, Mass.; Messrs. C. O. Bailey, Willis Munro, J. C. Gilbert, John W. Law, Alton E. Briggs, Boston, Mass.; and Messrs W. R. Walton, A. F. Burgess, L. H. Worthley, D. J. Caffrey, R. I. Smith and R. E. Snodgrass of the Bureau of Entomology.

According to *Science* the British Board of Agriculture and Fisheries has appointed a committee to study the life habits of the honey bee with the object of improving the conditions under which beekeeping is carried on in England and Wales, and to investigate the epidemic diseases of the bee, more especially the disease or group of diseases which pass under the name of "Isle of Wight" disease. The committee consists of: The Master of Christ's College, Cambridge (Dr. A. E. Shipley, F. R. S.); Professor Punnett, F. R. S. (professor of genetics, Crambridge); Dr. G. S. Graham Smith, M. D.; Professor G. C. Bourne, F. R. S., D. Sc. (professor of zoölogy and comparative anatomy, Oxford); Prof. W. Somerville (professor of rural economy, Oxford); Mr. T. W. Cowan (chairman of the British Bee-keepers' Association); Mr. G. W. Bullamore; Mr. J. C. Bee Mason; and Mr. A. G. L. Rogers (head of the Horticulture Branch, Board of Agriculture and Fisheries). Mr. R. H. Adie will act as secretary. It is proposed to undertake the study of healthy bees at Cambridge and the investigations on Isle of Wight disease at Oxford. The committee would be glad to receive specimens of bees suspected of suffering from "Isle of Wight" disease for examination and experiment.

Mailed October 26, 1918.

JOURNAL

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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 11 DECEMBER, 1918 No. 6

OBSERVATIONS ON THE MODE OF ACTION OF CONTACT INSECTICIDES [1]

By WILLIAM MOORE, *Division of Entomology and Economic Zoölogy, University of Minnesota*

During the present year, certain experiments have been conducted, which throw further light on the action of contact insecticides, and since it does not appear possible to make a more complete study in the near future, the following brief account is given in the hope that it will prove of some value to entomologists.

In a recent paper on essential physical properties of contact insecticides,[2] it was shown that fat solvents, oils and soaps were able to penetrate the tracheæ of insects by capillarity. It was further noted that heavy, practically nonvolatile and nontoxic oils, which had thus penetrated the tracheæ caused the death of the insects, but that the tissues of such insects were not stained by trypan blue (which stains dead tissue and not living tissues) until, ten, twenty or more hours had elapsed. From these observations, the question arose as to whether the insects did not die from the lack of oxygen resulting from the closing of the tracheæ. Shafer[3] has shown that methylene blue or indigo carmine injected into the body of an insect, which is then placed in an atmosphere free of oxygen, is reduced to its leuco compound and the body of the insect again becomes white or yellowish white. Upon

[1] Published with the approval of the Director as Paper No. 141, of the Journal Series of the Minnesota Agricultural Experiment Station.

[2] Moore, Wm., and Graham, S. A. Physical Properties governing the efficacy of Contact Insecticides. Journ. of Agr. Res. Vol. xiii, No. 11, 1918, pp. 523–538.

[3] Shafer, Geo. D. How Contact Insecticides Kill. Mich. Agri. Exp. Sta. Tech. Bull., 11–65 p., 1911.

being removed to the air, the stain is again oxidized and the body of the insect becomes blue. The following experiments were conducted to determine if treatment with an insecticide capable of plugging the tracheæ would thus reduce methylene blue.

Exp. 1. Larvæ of waxmoth (*Galleria mellonella*) were injected, with a saturated solution of methylene blue by means of a fine glass tube. Some of the larvæ were left as checks while others were dipped in a light lubricating oil. Larvæ not treated with the oil remained a beautiful blue while those treated, rapidly faded out, becoming white or yellowish white in three to five minutes. Since it was impossible to remove the oil from the tracheæ, the larvæ were then opened with a pair of scissors. The tissues and body fluids immediately turned blue on contact with the air.

Exp. 2. Same as Experiment 1 but when larvæ had become white, some of its body fluids were carefully removed by a capillary tube. A drop of this blood placed on a piece of filter paper or on a glass slide assumed a blue color in a few minutes.

Exp. 3. Same as Experiment 1 but olive oil used instead of a lubricating oil. Results exactly similar were obtained.

Exp. 4. Larvæ injected with methylene blue and then with olive oil. Although the larvæ died in a few hours, it remained blue both before and after death.

Exp. 5. Heavy lubricating oil, so viscous that it was unable to penetrate the tracheæ, was used to cover over a larva previously injected with methylene blue. Larva moved about for four hours, retaining its blue color, after which it was buried under a thicker layer of the oil with the result that it lost its blue color and was stupified within one hour. The oil was then removed as well as possible, but although the larvæ again assumed a bluish color, it did not survive the treatment.

Exp. 6. Injected larvæ dipped in toluene and removed; decolorized in six minutes. Injected larvæ dipped in carbon tetrachloride and removed; decolorized in six minutes. Injected larvæ dipped in xylene and removed; decolorized in seven minutes. Injected larvæ dipped in nitrobenzene and removed; decolorized in seven minutes. Injected larvæ dipped in nicotine and removed; decolorized in six minutes. Injected larvæ dipped in ether and removed; redipped, decolorized in thirty minutes.

Exp. 7. Injected larvæ placed in small vial with vapor of nicotine. Larvæ dead in four hours but color had not faded. Larvæ kept twelve hours but blue color did not fade.

Exp. 8. Experiment 7 repeated, using nitrobenzene and xylene with similar results.

Exp. 9. Injected larvæ placed in water, which did not enter the tracheæ. Started at 9.15 a. m., decolorized 9.28 a. m. Removed and excess water absorbed with filter paper. Larvæ again blue in color at 9.32 a. m. Larvæ were returned to the water at 9.40 a. m. and left until 2.10 p. m. They turned blue at once upon removal to the air.

Exp. 10. Injected larva placed in soap solution 1–500 in such manner that only the right spiracles were in contact with the soap. Removed and placed in pure water until colorless. Removed from water, dried, and left half of larva assumed a blue color while the right side remained colorless. Heart not beating and larva in stupor. Placed completely in soap solution and color faded out but did not reappear when larva was again dried and exposed to the air.

Exp. 11. Injected larva placed in soap solution until color had disappeared. Removed at 9.40 a. m. and color not having reappeared by 10.02 a. m. it was placed in distilled water and thoroughly washed until 10.20 a. m. Removed but color did not reappear by 10.37 a. m.

Exp. 12. One injected larva dipped in light lubricating oil so as to fill treacheæ of cephalic portion and another dipped to fill tracheæ of caudal end. Removed, heart beating and larvæ did not lose its blue color. Placed in water until stupefied and heart had ceased to beat. Larvæ now colorless were removed to the air and dried, when the portion with oil filled tracheæ remained colorless while the other half of the larvæ assumed a bright blue color. Later the larvæ revived, the heart started beating and the whole larvæ became blue.

Exp. 13. Injected larva placed in soap solution becoming colorless. Removed, carefully washed in distilled water and rolled on filter paper to remove as much as possible of the soap solution from the tracheæ. Within an hour, a bluish color developed in the vicinity of each spiracle, until after ten hours, the larva was irregularly blue over the entire body.

These experiments show that a contact insecticide containing oil or soap may penetrate the tracheæ of the insect; thus preventing normal oxidations from taking place in the insect's body with the result that the insect dies from their mechanical action alone. In order to insure death in this manner, it is necessary that all the tracheæ be filled with the spray. The vapor of the insecticide such as nicotine may produce death by chemical action without materially influencing the intake of oxygen. For small insects such as plant lice, an insecticide killing in a mechanical way alone will give good results, since all or nearly all the tracheæ will be filled. For larger insects, such as the tarnished plant bug (*Lygus pratensis* L.) filling all of the tracheæ becomes unlikely, hence it would be necessary to add to the spray an insecticide capable of killing in a chemical manner, thus insuring death, even if only one trachea is filled. Field experiments with sprays containing free nicotine have shown that the efficacy of such sprays is sometimes increased 50 per cent. by the addition of soap. These experiments were conducted during the past summer by S. A. Graham and will be reported by him elsewhere.

A further point, however, which has a decided bearing upon this question, arose in the study of the effect of laundering processes upon the destruction of active stages of the clothes louse (*Pediculus corporis*). In these experiments it was shown that the clothes louse was able to close its tracheæ quickly enough to keep out soap solutions, lubricating oils, xylene, and in seven cases out of twelve, even ether was prevented from entering. A few experiments have shown that the hog louse (*Hæmatopinus suis*) and the dog louse (*Hæmatopinus piliferus*) possess a similar power of keeping ether out of their tracheæ, but are not as successful in general as the clothes louse. The dog flea (*Pulex serraticeps*), mealy bugs (*Pseudococcus sp.*), soft scale (*Coccus* sp.), houseflies (*Musca domestica*), angumois grain moth, larvæ and adults (*Sitotroga cerealella*), tussock moth larvæ (*Notolophus leucostigma*) and pea aphis (*Macrosiplum pisi* Kalt) were all unable to prevent the penetra-

tion of ether, but this does not mean that some of these might not be able to shut out heavy oils or soap solutions. This whole question is interesting and if the parasitic lice, ticks, etc., should be found to possess this ability of closing the tracheæ rapidly, it will have considerable bearing upon the type of dips which would prove most effective. A similar cause may be an explanation of the difficulty of killing such insects as the tarnished plant bug. It is hoped to give this problem further attention at some future date.

THE CALIFORNIA PISTOL CASE BEARER[1]

COLEOPHORA SACRAMENTA HEINRICH

By W. M. Davidson, *U. S. Bureau of Entomology, Sacramento, Cal.*

Coleophora sacramenta Heinrich, Insec. Insci. Mens. II p. 145, 1915.
Coleophora sacramenta Hein.; Essig, E. O. Injurious & Beneficial Insects of California; Suppl. Monthly Bull. IV, 4. 1915.

Introduction

Since the year 1908, observations on the habits and biology of this insect have been made by agents of the Bureau of Entomology, Deciduous Fruit Insect Division, under the direction of Dr. A. L. Quaintance. The material in this paper has been arranged from notes made by Mr. J. R. Horton, Bureau of Entomology, formerly in the Deciduous Fruit Insect Division, by Mr. P. R. Jones, formerly of the Bureau of Entomology, Deciduous Fruit Insect Division, and by the writer. The greater part of the observations were made at San José, Cal., during the years 1910–1912, while some points in the life-history were subsequently checked up in 1916 at Walnut Creek, California.

Related Insects

The California Pistol Case Bearer belongs to a group of moths (Elachistidæ) of which a number are injurious to deciduous fruit trees. Among these are the Cigar Case Bearer (*Coleophora fletcherella* Fernald) the Western Cigar Case Bearer (*C. volckei* Volck) and the Eastern Pistol Case Bearer (*C. malivorella* Riley). The last named which attacks pomaceous fruit trees in the East is very similar to *C. sacramenta* in appearance and habits. According to Lowe[2] there are some minor differences; the larvæ of *C. malivorella* pupate on the twigs and branches, not on the leaves as in the case of *C. sacramenta;* the egg and pupal instars of *malivorella* in New York are passed in from 10 to 14 days, whereas those of *C. sacramenta* in California require a period of some 25 days.

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[1] Published with the permission of the Secretary of Agriculture.
[2] Lowe, V. H. Bulletin 122, N. Y. Agr. Exp. Sta., Geneva, N. Y.

Distribution

The insect appears to be confined to the San Francisco Bay region and to the counties of Santa Clara, Santa Cruz, Contra Costa, San Mateo and Alameda. In the Santa Clara Valley the species is at times quite abundant. In the San Ramon Valley in Contra Costa County it appears to be quite rare and has perhaps only been recently established.

Food Plants

These include plum, prune, cherry, apricot and apple. Decided preference is given to cherry, and plums (including prunes) of the European type.

Injury

Injury is caused by the larvæ only. Instances in which it has been damaging are few. The young larvæ from June to September skeletonize the foliage, feeding at first as leaf-miners. Old larvæ from late February to May attack leaf buds, fruit buds, flowers, foliage and occasionally the young fruit. When the larvæ are abundant they may destroy an appreciable number of fruit buds and blossoms, but in general, cherries and plums blossom so profusely that the buds and flowers destroyed by the case-bearers are a negligible quantity. Small brown scars are formed on the fruit.

General Biology

There is one generation a year. The adult moths emerge in May and June; the female after copulation deposits her eggs on the leaves of the food-plants. The eggs hatch after an interval of 26 days, the maximum date of hatching being about July 1. The young larva sets about constructing its "case" and once built this is never cast off but gradually enlarged as the larva inside grows. In their first instar the larvæ feed on the soft inner tissues of the leaf and skeletonize it. They feed thus until September and then proceed to the twigs and limbs to hibernate. Hibernation proceeds through the month of September, the larva fastening its case to the bark surface with a silken button. About the time when the buds are swelling in spring the larvæ resume active life and move to the young growth, feeding first upon the opening buds and later on the young leaves and fruit. When full grown they fasten their case to the leaf surface and pupate. Pupation occurs in April and May and after a lapse of 25 days the adult moths split apart the valve-like butt of the "pistol" and issue. From measurements taken periodically it appears that the larvæ molt once in the fall and twice in the spring previous to the pupal molt. Just

gs and limbs to attach their cases for hibernation. The case is tened to the bark surface by means of a silken pad or button and reafter the larva remains dormant until the following February or rch. Hibernating cases measure about 3 to 4 mm. in length, with apical width of about 1.6 mm., and the larvæ inside span about 4 a. A large percentage of larvæ die during the dormant period.

Activity in spring appears to be governed by climatic conditions d by the sap flow of the host plant. On a young Myrobalan tree der constant observation in 1912, it was found that the larvæ comnced feeding about February 18, but all had not become active until rch 21. In 1909 the commencement of activity on cherry trees ntinued throughout March and into April. The larvæ were obved to feed from March 7, at first eating the unopened buds and er the young foliage as it pushed forth. In 1910 and 1911 the young se-bearers started feeding on plum, apricot and cherry about the ne when the young leaves began to appear, roughly about March . In 1916, an early season, larvæ were working on plum and erry before March, and observations made on March 6 indicated at two-thirds had commenced feeding.

From measurements of larvæ collected in March it appears that a olt takes place shortly after they recommence feeding in spring d that a second occurs soon after. Thus on March 25 and 29, 1912, o lots of larvæ were collected, one of which had an average head dth of .53 mm., and the other of .84 mm., the head width of hiberting individuals being in the neighborhood of .38 mm.

In 1912 the earliest larvæ cast their second spring molt before March and on April 22 it was estimated from collections that about half individuals had cast this molt and that about 2.5 per cent had ached their cases preparatory to pupating. A considerable num- of larvæ must have been almost as far developed, for on April 27 was found that 40 per cent had turned around in their cases. Very rtly after this date pupæ were found and the latest larvæ pupated after May 20.

The above observations were made on a large series of case-bearers fined in a large cage over a Myrobalan plum tree.

In 1909 collections of pistol-case bearers were made in prune and rry orchards during May, and specimens which had been collected March and caged on apricot were also examined. One such lot red on apricot was examined May 6; the occupants of 71 cases coned of 4 active larvæ, 31 dead or inactive larvæ, and 36 pupæ. In t of 105 cases collected from prune May 8 there were on May 10, ving larvæ, 7 dead or inactive larvæ, 63 pupæ, and 31 parasitized æ. In another lot of 47 cases, collected from cherry May 8 and

examined May 10, there were 9 living larvæ, 12 dead or inactive larvæ, 23 pupæ, and 3 parasitized. On May 20, a lot of 59 cases was taken from prune and cherry; these consisted of 8 inactive larvæ, 1 dead larva, 43 pupæ, and 7 parasitized. On May 24, only pupæ were collected, and a few early moths were observed.

Observations made in the years 1910, 1911 and 1916 indicated similar dates for pupation.

Therefore it can be said that the larvæ commence their spring feeding as early as the middle of February and as late as the beginning of April, and that the majority begin to feed before March 15, that the period of pupation extends from the middle of April to the third week in May, and that the majority of the larvæ transform before the second week of May.

Unless while moving about, the larvæ contrive to anchor themselves to the plant surface by threads. Notwithstanding the presence of the case they are able to move with considerable agility when they so desire.

Position of Pupæ on Tree. (Pl. 15, fig. 2). On apricot the larvæ spin up chiefly on the leaves, being about equally partial to either surface; and to a much lesser extent on petioles and twigs. On prune and cherries the favorite location chosen is on the upper surface of the leaf at about the middle of the midrib, the case being attached to the rib; but a few individuals settle on petioles and twigs and a very small number dispose themselves on the under surface of the leaves and on the upper surface other than at the favored midrib location. As is the case with the feeding larva, the case projects from the plant surface at a right angle, whereas the cases of the hibernating larvæ often lie parallel to the surface of bark to which they are fastened.

Pupal Stage. The duration of the pupal stage varies with temperature and environment. Normally the pupa case is on the upper side of a leaf and receives much direct sunlight, and pupæ kept in close confinement or in shady quarters develop more slowly than those in natural conditions.

The following table indicates records of the pupal stage in 1910.

TABLE II. PUPAL STAGE, SAN JOSE, CALIFORNIA, 1910

No. Individuals	Date of Pupation	Date of Emergence	Pupal Stage, Days	Av. Mean Temperature
3	May 8	June 1	24	64.2
4	9	1	23	64.4
1	9	2	24	64.3
2	9	3	25	64.2
1	15	16	32	62.8
1	19	16	28	62.4

The average for the 12 individuals was 24.8 days.

THE LOTUS BORER

By F. H. CHITTENDEN, *Entomologist in Charge, Truck Crop Insect Investigations, United States Department of Agriculture*

The resemblance of the lotus borer to the recently introduced European cornstalk-borer (*Pyrausta nubilalis* Hübn.) is so close that the two species are apt to be mistaken for each other. It has, therefore, been thought advisable to bring together an account of the former from notes which the writer accumulated some years ago.

When this common pyraustine moth was given its specific name, *Pyrausta penitalis* Grote, a statement was made, from Prof. F. H. Snow, who supplied specimens from Lawrence, Kan., as follows: "Common; feeds upon the 'receptacle' of the Western Water-lily (*Nelumbium luteum*)."

This was in 1876.[1] Since that time the insect has several times come under notice as an enemy of this plant.

Some years ago the writer observed the larva in considerable numbers in raspberry canes. As about 40 per cent of the canes contained larvæ, it was naturally supposed that the species might prove a pest, more especially as we had also received larvæ boring in cornstalks. The result of studies of the insect's habits shows conclusively, however, that the hypothesis that it might do serious injury to other plants than the lotus was unfounded. A number of unrecorded observations, however, have been made, and these, with the Bureau of Entomology notes on the insect's life history, add considerably to our store of knowledge of this species. No extended article on this insect has been published so far as the writer is aware.

DESCRIPTION

The moth is pale yellow, and has been described as pale clear luteous, varying to ferruginous reddish luteous, with all intervening shades. The distinctness of the markings as shown in the accompanying figures (Pl. 16, figs. 1 and 2) has led to the species being described under a synonymical name. In faintly marked individuals the zigzag and other lines of both primary and secondary wings are very faint; in the darkest forms they are strong. The wing expanse is between three-fourths and one and one-tenth of an inch.

The larva when full-grown measures about an inch (25 mm.) in length. It is nearly cylindrical, being slightly depressed. It is marked with dark piliferous tubercles somewhat like the common

[1] Grote, A. R. Can. Entom., May, 1876, pp. 98, 99.

garden webworm (*Loxostege similalis*), as will be seen by reference to pl. 16, fig. 1, *b*, *c*, *d*. It is also of a similar color, which may best be described as dirty gray, with a dull reddish or purplish tinge.

The pupa (*e*) measures about half an inch in length, and just before the issuance of the moth is very dark brown, nearly black, the empty pupal skin being pale yellowish brown.

References to technical descriptions will presently be furnished.

Distribution

The list of localities from which we have received this insect and from which it is already recorded shows general distribution from New Jersey westward to Illinois and Kansas, and southward to Texas. The exact localities known are as follows: Bordentown, N. J.; Washington, D. C.; Urbana and Champaign, Ill.; St. Louis and Kirkwood, Mo.; Lawrence and Onaga, Kan., and Hockley, Tex.

History

This species came under the observation of Dr. C. V. Riley in its larval stage in the year 1876 in galls, evidently lepidopterous, on the so-called slender pink Persicaria, (*Polygonum incarnatum*). Moths from this lot began issuing May 29, continuing to June 6. The locality is not specifically mentioned, but it was undoubtedly St. Louis, Mo., as Dr. Riley was stationed there that year.

We have received larvæ from Miss M. E. Murtfeldt which were found boring in the stems of Eupatorium at Kirkwood, Mo.; also moths from the same source labelled October 9, 1884. In the biological collection of the National Museum is a moth reared from the stems of the wild water pepper (*Polygonum hydropiperoides*).

The first recorded description of the habits of this species is that by D. W. Coquillett in 1880.[1] The larva is there described under the name *Botis penitalis* Grote, with the statements that it "feeds on Indian hemp (*Apocynum cannabinum*)," that it "lives in a nest of leaves which are fastened together with silken threads," and that the species "assumes the chrysalis form in its nest."

An account of this species is also given by C. A. Hart,[2] in which mention is made of the occurrence of the larva in the large receptacles of *Nelumbo lutea*, and of its having been reared from larvæ boring in the stems of *Polygonum incarnatum* near Urbana, Ill. This account is accompanied by technical descriptions of the larva, pupa, cocoon, and imago, with notes on the insect's life habits.

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[1] Can. Ent., Vol. XII, p. 45. The description furnished of the larva shows considerable disagreement with what we now know to be *penitalis*, and it is probable that some other species was under observation.

[2] Bul. Ill., State Lab. Nat. History, Vol. IV, pp. 180–183, 1895.

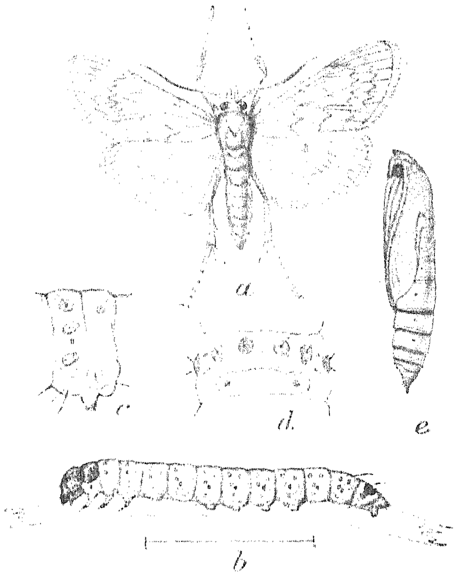

Fig. 1. The lotus borer (*Pyrausta penitalis*): *a.* male moth; *b.* larva, latera view; *c.* abdominal segment with proleg, lateral view; *d.* same, dorsal view; *e.* pupa from side—all enlarged. (Original.)

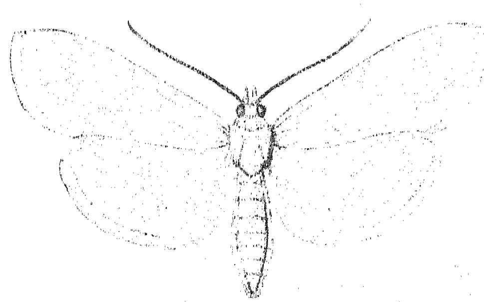

Fig. 2. The lotus borer (*Pyrausta penitalis*), female moth. (Enlarged, original.)

Fig. 3. Section of corn stalk showing perforations made in interior by lotus borer (*Pyrausta penitalis*), also exit hole at left. (Original.)

In the summer of 1889 Dr. J. B. Smith received specimens from Bordentown, N. J., where the caterpillar was feeding in the flower-stems and leaves, buds, flowers, and seed capsules of the Egyptian lotus. Assuming it to be a new species, a technical article was published on the insect under the caption "A New Species of Botis,"[1] and a popular one entitled "An enemy to the Egyptian Lotus."[2] The former includes a description of the species, as *Botis nelumbialis* n. sp., and of the mature larva. Both articles are illustrated with a figure of the moth, showing two color varieties, and of the larva with details.

August 28, 1890, we received larvæ from Mr. F. W. Thurow, Hockley, Tex., found feeding on the leaves and boring into the stems of *Nelumbium luteum* (=*Nelumbo lutea*).

November 31, 1891, we received from Mr. F. F. Crevecoeur, Onaga, Kan., pieces of the stalk of a late variety of corn (shown in pl. 16, fig. 3) which contained larvæ that were ultimately reared, the moths issuing the year following, March 12 and April 2.

The moths issued from June 4 to 14. One larva transformed to pupa May 16 and to adult June 2, in cool weather, having been in the pupal stage seventeen days. Another pupated June 3 and transformed to adult June 14, having passed eleven days as pupa; weather warm and sultry during the latter period.

As previously stated the finding of this species in abundance in the stems of raspberry led to the impression that the larva was injurious to that plant, and as a consequence a considerable number of specimens and infested canes were gathered for study. That this assumption was natural it will only be necessary to state that sketches were prepared at the time of the receipt of this species and its subsequent rearing in corn, and that the impression was an erroneous one is proved by the fact that there is no evidence that the species feeds on either healthy corn or raspberry, although it feeds on the pith to a considererable extent, but on the contrary develops chiefly upon lotus and other aquatic or semiaquatic plants and enters cornstalks and the cut ends of raspberry canes chiefly as a retreat for passing the winter and for subsequent transformation.

Summary of Life History and Habits

From available sources including the accounts of Smith and Hart, and from analogy, an approximate life history may be summarized as follows:

The species hibernates in the larval stage, the first moths issuing from March until June, according to locality. The eggs and place of

[1] Entomologica, Americana, Vol. VI, pp. 88–90, 1890.

[2] Garden and Forest, Feb. 19, 1890, p. 88.

oviposition have not been observed, but the larva when it first appears lives on the outer and upper surface of leaves in a little silken tent-like web, but it soon displays a strong tendency toward what is termed "inside feeding," in perforating and devouring buds and seed capsules and the interior of stems which may be available. During summer it feeds and grows apace until toward the end of August. It then crawls into whatever stems are convenient for the purpose and forms its winter retreat. From one to three or four larvæ sometimes enter a single stem; one is the usual number, although two are frequently found. In stems like those of raspberry the larva makes a burrow wide enough so that it can turn about if necessary, and measuring from an inch and a half to two inches. Both ends are frequently found plugged with small masses of pith, and when more than a single larva inhabits a stem their burrows are separated by a considerable mass. A small amount of silk is used in the construction of these hibernating chambers, and a little is usually to be found at either end. The writer has not seen in raspberry canes anything approaching a true cocoon, but it constructs them in other plants. Some of the hymenopterous parasites form a distinct cocoon.

The observed food plants are Lotus (*Nelumbo lutea*), Polygonum, Apocynum and Eupatorium.

NATURAL ENEMIES

Panzeria penitalis Coq. Less than half of the larvæ collected by the writer in the stems of raspberry were reared to the imago, the remainder being parasitized, chiefly by the tachina fly mentioned, which issued June 3 to 20, Washington, D. C.

Zemelucha (Porizon) facialis Cr. This ichneumonid parasite reared with the above June 3.

Three other tachina flies are recorded as parasites of this insect.[1] They are *Exorista vulgaris* Fall., *Hypostena variabilis* Coq., and *Phorocera comstocki* Will.[2]

Bracon xanthostigmus Cr. was reared at St. Louis, Mo., September 15, 1875.[3] This has also been reared on more than one occasion from blackberry canes, including some that were infested by *Agrilus ruficollis*.[4]

Mention is made in the article by Mr. C. A. Hart[5] of a braconid

[1] Technical Series No. 7, of this Bureau, p. 27.

[2] The first and last of these three tachinids were mentioned by Prof. C. H. T. Townsend (Psyche, Vol. VI, June, 1893) as having been reared from this pyralid by Dr. S. A. Forbes, Champaign, Ill.

[3] Insect Life, Vol. II, p. 349.

[4] L. c., Vol. IV, p. 257.

[5] L. c., p. 181.

and a chalcidid parasite of this species, the latter being secondary on the former.

In addition to the parasites which destroy this species, blackbirds are said to eat the larvæ before they go into shelter.

Control

A spray of arsenate of lead, Paris green or other arsenical could be used in the destruction of the young larvæ before they penetrate the interior of buds, seed capsules, stems, and the like. Where they are found at work in these shelters, however, about the only recourse would be to pick the affected portions by hand and burn them. The collection and destruction, also by burning, of the stalks in which the insects are found late in the season, is also advisable. In the occurrence of the insect on Lotus all parts of the plant containing the insect above the water line should be cut away as soon as this can be conveniently done.

ANASTREPHA FRATERCULUS WIED. (TRYPETIDAE)—A SEVERE MENACE TO THE SOUTHERN UNITED STATES

By E. W. Rust, *Entomologist of the Tucumán Experiment Station, Tucumán, Argentina*

In almost all tropic or sub-tropic lands fruit-growing is subject to severe losses occasioned by insect pests, and among the latter one of the most damaging is almost sure to be some one of the fruit-flies of the family *Trypetidæ.*

In the northern part of the Argentine Republic, where the writer is stationed, the particular scourge of the fruit-grower is *Anastrepha fraterculus* Wied., and during the past two years it has been the subject of more or less constant observation. During that time we have noted with surprise that so little is known, and even less published, about an insect which is such a menace to the fruit-growing interests of the semi-tropic portions of the United States. The Mediterranean fruit-fly is known by name and dreaded by a great number of fruit- and vegetable-growers, thanks to the wide-spread publication of the most excellent work done by the United States Bureau of Entomology. The melon fly (*Bactrocera cucurbitæ*) and the Mexican fruit-fly (*Anastrepha ludens* Loew) have also come in for some share of popular attention, but it appears that comparatively few people realize what a scourge *Anastrepha fraterculus* might become if once it gained entrance to the Southern portion of the United States.

Distribution

Anastrepha fraterculus might well be called the South American fruit-fly, as it is indigenous to, and well distributed over the warmer portions of South and Central America, and the West Indies, where it is regarded as only less destructive than the Mediterranean fruit-fly. Moreover, it occurs as an extremely destructive agent in many sections where the latter has not as yet gained entrance. So far, we have authentic records of its occurrence in Brazil, Argentina, Peru, Colombia, Yucatan (Mexico), Cuba and Porto Rico. Beyond a doubt it is found in most of the other islands of the West Indies, but has not been definitively reported as yet. Northern Chile, Ecuador and the various Central American States will doubtless be added to the list also, as soon as anyone is in a position to search these regions, as it seems certain that this fly has penetrated to all the warmer portions of South and Central America where fruit is grown. In some sections it is as yet only a menace, while in others it has assumed almost the proportions of a calamity.

Damage Done

In the Province of Tucumán (Northern Argentina) *Anastrepha fraterculus* is variously known as "la mosca de la fruta" (the fruit-fly), "el gusano de la fruta" (the fruit-worm), "la mosca del naranjo" (the orange fly), and "el gusano del naranjo" (the orange worm). It is definitively known to have been present at least twenty years, and in conversation with old residents, the writer has learned that as long ago as the natives can remember, thin-skinned fruits, such as peaches and chirimoyas, have been regularly destroyed by a maggot, which is described as identical to that found in all kinds of fruits today. After a thorough canvass of the situation, there seems little reason to doubt that the fly is indigenous to this section, or has at least been present for several decades.

During this period it had been noted that the pest caused more damage during certain years than others, and this fact was attributed to combinations of climatic factors not completely understood. However, it appeared certain that the maximum amount of sound fruit was obtained following seasons during which climatic extremes of one kind or another had occurred. But even after such periods unfavorable to the fly a large percentage of the local peaches and apricots were apt to be wormy; in bad years practically all soft or thin-skinned fruits were destroyed, and in recent years even the various species of citrus have been, in their turn, badly infested. This latter condition is, however, of only recent date, for it is only within the last three or four years that any infestation of citrus fruits has been noticed; but during

this period the condition has become more and more wide-spread and the percentage of infested oranges has increased until during the autumn of the present year (March–April and May, 1918) a loss was experienced of nearly 50 per cent. of the oranges in some sections; and one grower reports the dropping of at least three-fourths of his crop of pomelos through the agency of this insect.

Conditions at present are worst in the Province of Tucumán, and it is in the central and southern portions of this province only that oranges are severely damaged. On the other hand, almost all thin-skinned fruits are more or less subject to infestation in most parts of Northern Argentina. In the Province of Salta and the majority of the Province of Jujuy peaches and apricots are generally almost a total loss, due to the rot engendered by these maggots, and chirimoyas or "custard apples," plums, etc., are regarded with suspicion until after a thorough examination. Although very excellent oranges have been produced in that section (notably at Orán, Salta) for more than one hundred years, the fruit-fly does not seem to have adapted itself to that host to any great extent, as yet, in the two provinces named, but indications point to a heavier infestation in the future. The writer saw evidences of oviposition in nearly every orchard visited in those provinces during May of the present year, and ventures that before the lapse of many years even the wild oranges in the forests around Orán will be the regular hosts of this fruit-fly, which seems to be gradually extending its ravages to fruits heretofore considered immune. Conditions which will bring about a serious infestation of these oranges will be a season when many flies have emerged, followed by a sudden diminishing in the usual quantity of thin-skinned fruits of late summer or autumn, which will force large numbers of flies to oviposit in the oranges.

Description of the Fly

The adult of the maggot which makes all this havoc might be said to resemble, in a general way, the common house-fly, except that the former is yellowish-brown in color and of somewhat larger size. In this matter of size, some latitude should be allowed, for individuals of both sexes vary greatly in this particular, in accordance with the conditions under which they developed. The writer has seen a statement to the effect that the female measured about 12 mm. in length (exclusive of the ovipositor) by slightly more than 25 mm. across the extended wings. The foregoing is, however, a trifle large, as an average, for the flies which occur in the region under discussion. Data obtained from the examination of large series of individuals show the following characters:

Length of average female (exclusive of ovipositor), 8 to 9 mm.; length of ovipositor, 2 mm.; wing expanse, 18 to 20 mm. Length of average male, 7 to 8 mm.; wing expanse, 15 to 16 mm. Eyes conspicuous, of living or recently killed specimens, beautifully irridescent but gradually turning dark brown to blackish. Body yellowish-brown to almost castaneous, except ventral side of thorax which is very light brown to straw-colored; thorax with three sulphur colored, longitudinal stripes on dorsum and another on each side reaching from wing base to head; scutellum sulphur-yellow, abdominal segments edged with light yellow, giving appearance of three well-defined transverse stripes. Wings comparatively large and relatively more slender than those of *Ceratitis;* hyaline, stained in places with a distinctive pattern of yellowish-brown which involves the base of the wing and extends (with one slight interruption) in a broad stripe along the anterior margin to the tip; the interruption alluded to leaving a small notch-like, clear spot near the center of the anterior wing-margin, and from the lower angle of this spot another band curves downward and backward to the basal angle of the wing; on the distal half of the wing is another streak, like an inverted V, one prolonged arm of which rests upon the posterior wing-margin, while the apex almost (and in certain cases, quite) joins the aforementioned stripe along the anterior margin, at a point just distad of the clear spot. Wings irridescent in certain lights. In freshly emerged individuals the eyes are unusually conspicuous and flash combinations of red and blue which vary with the light. Newly emerged flies are wholly straw-colored, with nearly clear wings, but the body soon darkens and the characteristic patterns on both body and wings soon become well-defined. The wing pattern does not seem to be absolutely constant, and some slight variations, both of shade and pattern, are often noted. Female ovipositor brown, tipped with black hairs, stout, mainly cylindrical but slightly flattened on the under side, tapering uniformly to the tip.

Oviposition

When a female fly is ready to deposit eggs, her first care is to find a suitable host in which to place them. Various kinds of fruits serve for this purpose and they are attacked in various stages of maturity, according to the fruit chosen and the season of the year when oviposition takes place. When the female fly alights upon a fruit, she first explores the surface, all the time gently waving her wings in the manner characteristic of these insects. Then when a seemingly satisfactory point is found, she stops and bends the ovipositor at right angles to the body, the abdomen remaining in the customary horizontal position and the ovipositor being bent at the point where it joins the abdomen. In this position the tip of the ovipositor just touches the surface of the fruit. Then the stylets are exerted and introduced into the rind. As they enter, the fly sways slightly backward, so that the ovipositor forms an acute angle (about 50 per cent.) with the body, in which position she remains during the major portion of the time occupied in oviposition, which varies from a trifle over thirty seconds to about a minute and a half. Then ensues a period of rest and exploration of from two to three minutes, before another puncture is made. The eggs are elongated, somewhat spindle shaped, whitish in color

and about 1 mm. in length. They are sometimes placed singly but often several occupy the same cavity and a single fruit may be oviposited in many times by the same or by different insects; thus it may happen that a fruit bears the marks of the ovipositors of so many females as to almost cover its surface with scars.

The Larvæ

The eggs hatch, commonly in from two to four days, into minute white larvæ, which immediately start eating their way through the fruit. These larvæ are of the usual maggot type, slenderly pointed at the forward end and terminating bluntly at the opposite extreme. As they grow they also darken in color until when three-fourths grown they are creamy white, after which they become creamy, to yellow, and finally attain a length of from 7 to 9 mm. or even 10 mm. In summer the larval period averages from twelve to fifteen days, which may be prolonged to several weeks by the cold of winter.

The Pupæ

Upon becoming full grown the larvæ leave the fruit and burrow several centimetres into the soil, there to form the pupa, which is of the usual castaneous, capsule-like type. Or the pupa may be formed under the first convenient object, or even in an exposed position if the larva cannot bury itself. The pupal period also varies greatly, ranging from twelve days to several weeks, according to temperature.

The Adult

Upon emerging from the pupa, the adult fly is very soft and can easily make its way through the small cracks and interstices of the soil until it reaches freedom at the surface. There its body hardens and the wings expand until it is able to fly in search of the fruit juices, sap or honey-dew upon which the adult normally feeds.

In confinement the flies die within three or four days, unless supplied with food, but if syrup or juicy fruit is supplied them, they may live for astonishing lengths of time. Without any special attention, the writer has kept flies alive for more than three months and has no idea but that this period may be greatly prolonged under more favorable conditions. In this connection, it was noted that the males generally died first, just as they often are first in emerging from the pupa.

Fertilization of the female often takes place during the first day after emergence, and eggs have been secured upon the third day, but generally oviposition begins upon the seventh or eighth day after emergence and may continue for a long period. The maximum length of time during which a female may deposit eggs has not yet been deter-

mined, nor has the maximum number of eggs laid per day, but as several eggs seems the normal rate per day during a prolonged period, it seems reasonable to calculate that the average female *Anastrepha fraterculus* is capable of depositing between 500 and 800 eggs during her lifetime.

Host Fruits of A. fraterculus

The eggs are deposited in, and the resulting larvæ more or less completely destroy the following fruits, according to a recent list published by the United States Federal Horticultural Board.:[1]

Guava (*Psidium guajava*), coffee berries, pear, peach, mango, orange, *Eugenia* spp. *Phylocalyx,* Japanese plum, Japanese persimmon, Pará plum, (*Spondias* spp?) *Anona humboldtiana,* jobo amarillo, jobo de la India.

To the foregoing can be added the following fruits which the writer knows to be infested in Northern Argentina: strawberry guava (*Psidium* [*Campomanesia*] *cattleyanum*), Chinese guava (*Psidium* [*Campomanesia*] *lucidium*), fig (*Ficus carica*), pomelo (*Citrus decumana*), kumquat (*Citrus japonica*), tangerine (*Citrus nobilis*), apricot (*Prunus armeniaca*), avocado (*Persea americana*), chirimoya (*Anona cherimola*). In addition it may be stated that the fruits of *Feijoa selowiana* have been reported as infested at times, and that in several instances the writer has found lemons (*Citrus medica limonum*) which showed evidence of having been "stung" by the fly, although no larvæ have so far been found in the last named fruit.

Methods of Attack in Different Types of Fruit

In the region under discussion the first fruits to be attacked in the spring are probably the apricots, which are soon followed by peaches, and it is the latter fruit which may be regarded as the principal summer host of the insect. Adult females which have successfully passed the colder months or which have emerged from over-wintering larvæ or pupæ, become active early in spring and place eggs in early apricots where the larvæ develop at a comparatively rapid rate. These larvæ give rise to a large number of flies which are ready and waiting for the early peaches, and in the haste to deposit eggs some fruits are "stung" while yet not much more than half-grown, but in these the larvæ are not able to develop. Such peaches may drop or may cling to the tree, but in any case they "mummify" and do not become soft with rot, which latter condition seems to be more or less essential to the success-

[1] A Manual of Dangerous Insects Likely to be Introduced in the United States Through Importations. Edited by W. Dwight Pierce. Washington, D. C., Aug. 15, 1917.

ful development of the larvæ. The most propitious time for oviposition in peaches seems to be two or three weeks before the fruit would normally ripen. At this time they are still firm and green, but the pulp loses its excessively hard, dry, astringent qualities and becomes sweet enough and moist enough to nourish the young larvæ. These now develop very rapidly and eat out a large part of the flesh and cause the rest to rot so that the larvæ are nearly always enveloped in a decaying mass which seems exactly to answer their requirements. At this stage the fruit colors up and may appear normal except for a few small holes which the worms make in order to obtain air, but it is soft to the touch, and when opened presents a disgusting mass of corruption, filled with from three or four to thirty or more wriggling, whitish maggots. This decay causes a premature ripening of the unattacked flesh and the whole fruit falls to the ground at a time when sound fruits of equal age have as yet scarcely begun to ripen. If it still contains undeveloped maggots, these are generally able to finish their development in the fruit upon the ground.

Under the favorable conditions of abundant food and suitable temperature which obtain at this season, the egg period is passed in two days, larvæ develop in another seven to ten days; and the pupal period is passed in twelve to fifteen days more, so that we may have adults from eggs deposited only three weeks before. This, however, is the minimum, attained only under the most favorable conditions, and the normal time from one generation to another is very close to thirty days in summer.

By the end of the peach season, the flies have reached their maximum number and there is scarcely enough fruit for all to place their eggs in during years of heavy infestation, so almost any kind of fruit is used for oviposition, but only in certain kinds do the maggots succeed in developing. After the peaches have all been destroyed, the females turn their attention to later fruits, such as chirimoyas and guavas, each of which serve as host for one or more generations of the insect. Fruits then become somewhat scarce and not much is left except persimmons, which to some extent engage the attention of such females as are bent on oviposition. Thus pass the summer months of December, January and February and oranges will soon be in a condition to attack. Meanwhile the females content themselves with eating, sunning themselves in warm nooks, or keeping in the shade at mid-day, and waiting. They can pass long periods without depositing eggs and yet be in perfect condition to resume this function as soon as an opportunity is presented, so their numbers do not diminish to any very great extent during a short scarcity of fruit. By the end of February or the beginning of March oviposition begins in oranges but the fruit is gen-

erally too green and very few if any of the first maggots develop, even if the eggs hatch. But from the middle of March to the last of April, or even longer during favorable weather, larvæ regularly develop in many of the oranges of this section. Especially is this true in thin-skinned varieties or those with a loose peel such as the tangerines have.

Eggs are often deposited in large numbers in oranges, but no larvæ develop. This was very puzzling at first but it has since been found that during oviposition some of the oil cells, so numerous in citrus fruits, are often ruptured and the strong essential oil thus liberated destroys the eggs. But even if this accident is escaped, not all danger is passed, for if the eggs be deposited in very thick-skinned fruits such as bitter oranges, pomelos, or even some seedling oranges, the larvæ are very apt to starve to death before they can penetrate the innutritious rind and arrive at the pulp on which alone they can thrive.

Another puzzling question was why the fruit so often dropped when no signs of larvæ could be found in them. After extensive experiments it was proven to the writer's satisfaction that even if no eggs were deposited by the female at the time oviposition was attempted, yet the resulting punctures were often sufficient to allow the fruits to become infested with *Colletotrichum* and other fungus spores or by bacterial rots which caused a premature ripening and fall of the fruit, and it is probable that the ovipositor of the female really acts as the vehicle of infection in many cases. Especially was it noted that pomelos are almost sure to develop typical *Colletotrichum* spots after being "stung" by the fly, and it is due to the fungus and not to the fly larvæ that they drop prematurely, for the fly larvæ rarely reach maturity by tunneling the thick rind of this fruit. The eggs may hatch and the young maggots may feed for awhile but they generally die before pupating.

The growth of *A. fraterculus* larvæ in citrus fruits is slower than in the other fruits mentioned, and this may be due partly to the qualities of the fruits themselves, but is more apt to be the effect of the lower temperature which always occurs during the autumn and winter, when the citrus fruits are ripening. During the first part of the season larvæ developed in the orange in from twenty to thirty days and then remain in the pupal stage from fifteen to twenty-five days longer (according to temperature) or a matter of from thirty-five to fifty-five days for the immature stages, but as the weather grows colder development becomes slower until finally it stops completely and the coldest season is spent in a quiescent state by both larvæ and pupæ, but the adult continues actively feeding during warm days even if the temperature has dropped as low as freezing the previous night. Thus we have *A. fraterculus* passing the coldest months of July and August as larvæ in citrus fruits, as pupæ protected by the soil, and as adults, which have

been seen to survive temperatures as low as $-7°$ C. By means of this resistance to unfavorable conditions all stages are able to withstand the cool weather and resume their normal activities with the more favorable weather of early spring, when a new swarm, composed of both over-wintering females and those freshly emerged, is ready to attack the early apricots, thus completing the yearly cycle.

Climatic Conditions

Climatic conditions seem to be the decisive factor as to whether this insect will be severely destructive or only moderately so. If conditions have been favorable to a heavy crop of fruit, a good proportion of the same may, during the first part of the season, be free from attack, but from this very abundance of food results such a great and rapid increase of flies that the fruit maturing during the remainder of the season is apt to be very largely infested. Thus, a big peach crop gives rise to a swarm of fruit-flies which multiply rapidly in the many successive and suitable summer fruits, until oranges are sufficiently developed for oviposition in the autumn. These, being practically the only fruit left, receive the full attention of almost all the flies and a heavy infestation results. On the other hand, unfavorable weather conditions tend to check the increase of the fruit-fly, but sometimes they also result in curtailing the fruit crop as well, so that things are pretty evenly balanced and nearly all the fruit is again infested. However, if the unfavorable weather occurs early enough in the season, the flies may be severely checked without doing much damage to fruit-trees which have not bloomed as yet, and a good crop of comparatively clean fruit results.

Now, what climatic conditions may bring about these results? Naturally one thinks of cold. But a cold spell of sufficient duration and intensity is seldom encountered in the semi-tropics. Nor is it a condition to be desired from other points of view. During the present winter this locality has suffered from temperatures of from 0° C. to $-7°$ C., followed by warm sunshine, and at mid-day many specimens of *A. fraterculus* were observed as active as ever. Thus it appears that even a killing frost does not have much effect on the adults, and even less on larvæ in oranges or upon pupæ which may be safely protected in the soil.

As to humidity. Where rains occur in the hot season, as here in Northern Argentina, they only stimulate plant growth and tend toward increasing the food supply of the flies and to the rapid development of the latter in all their stages. In fact it has been noted repeatedly that during and after a rainy season, damage by the fruit-fly is generally more severe.

Conditions due to altitude cannot be thoroughly discussed until more data are collected, but it appears likely that this is not an important factor, from a practical view-point, if other conditions are favorable, as the fly has been collected by the writer at various elevations, ranging from 1,000 feet to nearly 4,000 feet. In other and more tropical regions it has been collected at slightly above sea level, so it appears safe to venture that this insect is capable of making itself very obnoxious at any altitude up to at least 4,000 feet, if conditions of temperature, etc., are favorable.

There remain to be discussed, heat and drouth. These two factors often occur together, and when they are severe are certainly a great check to the fruit-fly. Either condition alone may greatly curtail the insect's food by causing fruit-trees to bloom but scantily or by causing fruit to drop after it has been formed. When both heat and drouth are severe (and especially if prolonged) fruit is certain to be very scarce and the fly is consequently checked in its multiplication, in which case the fruit of the succeeding season will be comparatively free from maggots. Not only do the above conditions cause a scarcity of the flies' food, but many larvæ and pupæ are killed outright and the adults are greatly restricted as to the time during which they can oviposit. With a temperature much over 100° F., larvæ are often literally cooked in the fruit which fall in the sun, before they can escape and enter the soil; and even if they do succeed in burying themselves, such excessive temperatures as were experienced in Tucumán during the summer of 1917[1] were enough to bake them everywhere the sun reached. Such a temperature is also fatal to emerging flies, and even the mature adults refuse to oviposit during the hotter parts of the day, but remain motionless on the underside of leaves, or upon the ground in the shade. It has been noticed that after a prolonged hot, dry period, *A. fraterculus* is much less numerous than usual and that unless very favorable conditions for its rapid increase occur during the succeeding winter, spring or early summer, the fruit of these seasons will be comparatively free from attack by the larvæ. However, by the end of summer they have generally become numerous enough to again be conspicuous and to do a large amount of damage during the succeeding year, unless something happens to give them another check.

Parasites

This check to their multiplication may be either natural or artificial, and in addition to causes of the former kind discussed above, may be mentioned parasites. However, these are, as yet, very little known.

[1] January 20, 1917. Maximum at the Experiment Station, 114° F. in the shade. Maximum in the city of Tucumán, 118.5° F. in the shade.

In rearing thousands of specimens of *A. fraterculus* from all sorts of fruit hosts, only a very small number of parasites have thus far been encountered and these were all a certain *Ichneumonid* as yet undetermined. It has been reported that other parasites attack *A. fraterculus* in Brazil, but the writer has no authoritative information as to how effective a check they really are. Doubtless some of the parasites of *Ceratitis capitata* could be used to good advantage against our South American fruit-fly, but the opportunity for giving them a trial has not yet presented itself.

Artificial Control

As is often the case with other species of fruit-flies, artificial control of any kind has not yet proven very successful against *A. fraterculus*. Such measures have been recommended as the destruction of infested fruit, the capture and destruction of adult flies, poisoned sprays, etc., but conditions here, as elsewhere, prevent such measures from being effective. People in general are too careless or indifferent to the clean cultural measures recommended and very little can be done at general control until every individual is willing to shoulder his portion of the responsibility. Poisoned sprays give some promise of being useful under certain conditions and will be given a more extensive trial during the coming year.

THE LIFE HISTORY AND EARLY STAGES OF CALOPHYA NIGRIPENNIS RILEY

By Harry B. Weiss and Alan S. Nicolay, *New Brunswick, N. J.*

According to E. A. Schwarz in his paper "Notes on North American Psyllidæ" (Proc. Ent. Soc. Wash., Vol. VI, p. 234) the development of this species was carefully studied by Mr. Theo. Pergande many years ago and some fine drawings illustrating the various stages were made by Dr. Marx. However the manuscript and some of the drawings could not be found after the death of Dr. C. V. Riley. The drawings, of the first and second larval stages, which accompany this paper were copied from those by Dr. Marx, which appeared in Mr. Schwarz's paper.

The species appears to live exclusively on *Rhus copallinum* L., and ranges according to Van Duzee (Check List of the Hemiptera of America, North of Mexico) from Connecticut southward to Georgia and Florida. In New Jersey we have found *Calophya nigripennis* to be fairly common although it does not by any means occur every place where its food plant grows. According to Stone (N. J. State Mus. Rept., 1910) *Rhus copallinum* L. is found frequently in sandy soil

throughout the northern, middle and coast districts of New Jersey and occasionally in the pine barrens where it is introduced. In several localities we found plants which were heavily infested by the insects, but hardly any noticeable injury was observed. In a few cases, a slight discoloration of the foliage was noted together with some disfiguration of the upper leaf surfaces due to the numerous third stage nymphs which had collected there.

Adults appear about the middle of May in the southern part of the State and about a week later northward and can be found in diminishing numbers up to about the first week of July. For the vicinity of Washington, D. C., McAtee (Ent. News, Vol. XXIX, p. 222) states that they are abundant from May 4 to June 29. After copulation, egg laying takes place, the foliage on the tips of the twigs usually being selected for this purpose.

The eggs are light, lemon yellow when first laid and later become brownish or brownish black. They are fastened singly to the leaf by means of a short peduncle which is inserted in the tissue. The edges of young leaves are favorite places for egg deposition, from two to forty eggs being found on a single small leaflet. The edge of the winged blade of the stem of the compound leaf is also a favorite place for the eggs and in some instances, eggs were found on the upper and lower leaf surfaces, usually close to or on the midrib. The incubation period is from two to three weeks, the first stage nymphs appearing about the middle or last part of June. The insect passes through four nymphal stages, each one of the first three requiring about a month to mature.

By the middle and last week of September practically all of the nymphs are in the third and fourth stages and have sought hibernation quarters on the woody stems. The first two nymphal stages can be found as a rule on the under sides of the leaflets and blades of the stem, many of them feeding with their heads close to the midribs.

After reaching the third stage they appear to migrate to the upper sides of the leaves and especially the upper sides of the blade-like extensions of the stem, where they rest with their heads close to the stem. Most of the fourth stage nymphs and many of the third stage are found on the hairy twigs of the plant, close to the lenticels or crowded as far as possible under the buds in which places they hibernate during the winter. This method of hibernation was noted by Schwarz.

Individuals of the first two nymphal stages are very flat and light yellowish in color. Those of the third and fourth stages are convex, dark in color and covered with globular tubercles of varying sizes arranged in a symmetrical pattern. The color of the last two stages resembles closely the bark of the twigs on which they hibernate. All

of the nymphal stages are fringed with waxy threads, which break readily. These threads are not as long as those with which the nymphs of *Trioza tripuncata* are clothed, but nevertheless are plainly visible. During the process of clearing the specimens the wax threads are lost and only the bases remain, which appear as short spines. In the illustration accompanying this paper, the drawings were undoubtedly made from cleared specimens.

It is thus seen that there is only one generation each year and that development is very slow. This slow nymphal development is characteristic also of the bramble flea louse, *Trioza tripunctata,* for this latitude as noted by Smith (Rept. Ent. Dept., N. J. Agric. Coll. Exp. Sta., 1911, p. 418). In striking contrast to this is the development of the pear psylla, *Psylla pyricola,* in New York which is four brooded during a season, one month being required for a complete life cycle (Slingerland & Crosby, Manual of Fruit Insects, p. 219).

Egg: Length 0.19 mm. Width 0.06 mm. Elliptical, both ends rounded. Chorion apparently smooth, shining black or brownish before hatching; slightly flattened where it rests against leaf. Whitish slender peduncle almost as long as the width of the egg arises usually at a slight angle from a point about one-fourth of the length of the egg from one end.

First Stage Nymph: Length 0.22 mm. Width 0.15 mm. Shape oval, rounded anteriorly and posteriorly, body flat, widest across mesothorax. Color lemon yellow,

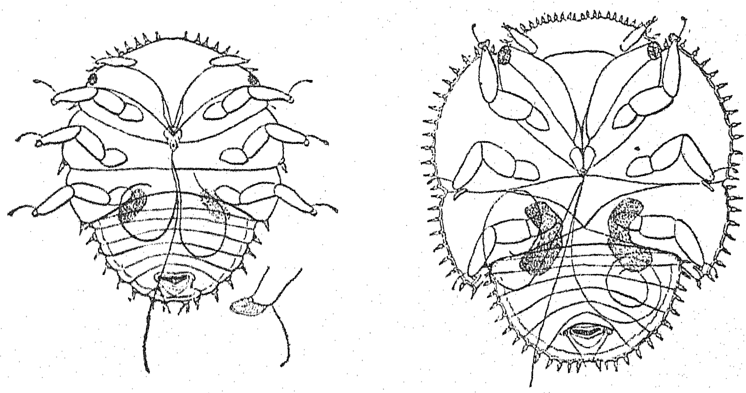

Figure 16. *Calophya nigripennis*, first and second nymphal stages (after Marx).

central portion slightly greenish. Body segmentation indistinct. Antennæ cylindrical, tapering to distal end which is truncate and bears a comparatively long spine-like hair. Eyes red, on lateral margins of head; head triangular. A fringe of minute spines on anterior margin of head. A minute spine on posterior lateral angle of each thoracic segment. A single spine on the lateral margin of each abdominal segment. All spines in this and later stages rest on minute tuberculate bases and terminate in wax-like hairs. Legs stout, cylindrical, tapering toward tip, apical end

bearing sucker disc and comparatively long spine-like hair. Basal sheath of rostrum extending to between bases of first and second pair of legs.

Second Stage Nymph: Length 0.35 mm. Width 0.35 mm. Shape suboval, widest across mesothorax, narrowest across abdomen, rounded anteriorly and posteriorly, sides of meso- and metathorax arcuate and extended laterally. Color, antennæ and eyes somewhat similar to those of preceding stage. A fringe of minute spines on anterior margin of head, on lateral margins of meso- and metathorax and a pair of spines on the lateral margin of each abdominal segment. Legs somewhat similar to those of preceding stage.

Third Stage Nymph: Length 0.5 mm. Width 0.49 mm. Shape subcircular, anterior end truncate, posterior end rounded; dorsal surface convex; body broadest across thorax and narrowest across abdomen. Color light yellowish to dirty brown, some individuals being additionally marked with black spots. Body segmentation distinct. Antennæ cylindrical, tapering to truncate distal end which is dark and bears two spine-like hairs. Eyes distinct, red. Wing pads more pronounced and extended laterally. Lateral and frontal spines similar to those of preceding stage but more pronounced. An irregular, transverse dorsal row of yellowish or white tubercles on anterior portion of triangular head, a median, dorsal, double row extending from the transverse row to the end of the abdomen. On either side of the median, double row is a somewhat arcuate row starting at the end of the transverse row on the head and extending into the abdomen but not as far as the median, double row. Between these rows are smaller scattered tubercles. Largest tubercles are found on head and thorax. Ventral surface and most of legs light. Distal ends of legs dark, bearing pulvilli, a pair of claws and a spine-like hair. Basal sheath of rostrum extending to between the bases of the second pair of legs.

Fourth Stage Nymph: Length 0.7 mm. Width 0.78 mm. Shape, subcircular, anterior end truncate, rounded posteriorly. Dorsal surface convex; body broadest across thorax, narrowest across abdomen. Color varies from light brown to black, some individuals being spotted with black. The color of the tubercles varies from yellowish to white. Body segmentation distinct. Antennæ similar to those of preceding stage. Eyes distinct, red. Sides of mesothorax extended laterally and anteriorly to anterior margin of head; sides of metathorax extended laterally and posteriorly to almost the middle of the abdomen. Entire periphery of body fringed with waxy threads which break off leaving spine like processes. Entire dorsal surface covered with various sized tubercles, with the following most prominent: transverse irregular row on head just behind the eyes, a median, dorsal, double row extending from transverse row through abdomen, a curved row on either side of median double row and extending from the end of the transverse row on the head to the anterior part of the abdomen. In some specimens there were two curved rows on either side of the median double row. These curved lateral rows are not as prominent in this stage as in the third stage, due to the numerous other tubercles which are present. The entire dorsal surface has a pebbled appearance. Ventral surface and legs similar to those of preceding stage but darker. Legs bearing a few scattered spines. Basal sheath of rostrum similar to that of preceding stage.

Adult: Calophya nigripennis Riley, 1884 *rhois* (Glover), 1877. Crawford in his monograph (U. S. N. M. Bull 85) gives the following redescription. "Length of body 1.7 mm; length of forewing 2.1; width of head 0.72. Color of vertex, wings, and anterior and middle femora black to brown, wings sometimes light brown; abdomen light brown to almost black; genal cones and thorax bright orange or sulfur-yellow; antennæ, except at tip, posterior femora and all tibiæ pale yellow. Vertex smooth, seldom alutaceous, shining, very convexly rounded downward in front, more so than

in the other species of the genus. Genal cones small, not as long as basal width, often distinctly shorter, acute at apex, divergent, subhorizontal, not pubescent, contiguous at base. Antennæ shorter than width of head, thick, always black at tip. Thorax smooth, less strongly arched than in preceding species, sometimes faintly alutaceous, sometimes striped on dorsum. Forewings thick, not transparent, somewhat punctulate, narrowly rounded at apex, about two and a half times as long as broad, pterostigma long and large; first marginal cell about twice as large as second. Hind wing somewhat fumate. Genitalia—male—genitalia similar to *flavida;* anal valve broad, about two-thirds as broad as long, convex on both hind and front margins; forceps as in *flavida*. Female—genital segment scarcely as long as two preceding ventral sclerites, stout, not acuminate."

THREE SPECIES OF ANASA INJURIOUS IN THE NORTH (HEMIPTERA, COREIDÆ)

By H. M. Parshley, *Smith College*

The common squash-bug, *Anasa tristis* De Geer, was until recently the only species of the genus known to occur in New England. In 1914 C. W. Johnson reported[1] the occurrence of *A. repetita* Heidemann in Massachusetts, and up to the time of publication of my New England list[2] only two additional records came to light. Subsequently I called attention to the discovery of the species in large numbers on the star-cucumber, which would appear to be its natural food plant in this region.[3] Last June I noted *repetita* feeding on young plants of the cultivated cucumber in numbers probably sufficient to have caused some injury, if hand picking had not been employed as a preventive measure.

The case is similar with *A. armigera* Say, long known as injurious in States farther south. In 1914 I met with the first known New England example while sweeping underbrush in a woodland near Boston and took another in the same spot the following year.[4] In the New England list is noticed but one additional capture, at Amherst. I have since taken *armigera* in moderate numbers, feeding on the star-cucumber, and early in the present summer I found it attacking the cultivated cucumber in company with *repetita*. The late generation, consisting entirely of *armigera*, appeared about the middle of August on the cultivated cucumber in such numbers as to destroy some of the plants. From a single vine sixty specimens were collected.

Thus it appears that *repetita* and *armigera* are increasing in numbers in this region, with the likelihood that they will become seriously in-

[1] Psyche, Vol. 21, 1914, p. 82.

[2] Occas. Papers, 7, Boston Soc. Nat. Hist., Fauna of N. E. 14, Hem. Het., 1917.

[3] Psyche, Vol. 25, 1918, p. 64.

[4] Ent. News, Vol. 27, 1916, p. 106.

jurious to cucurbitaceous vegetables; possibly as important in this respect as *tristis*. Present knowledge indicates that the cucumber is preferred, as neighboring squash vines have so far escaped attack. The familiar measures employed in the control of *tristis* are indicated in the case of the other two species, and in addition I would suggest the eradication of the star-cucumber (*Sicyos angulatus* Linn.), as a measure of precaution.

As it will be of interest to have further precise observations on the activities of these potentially destructive species of *Anasa*, I append a table for their discrimination, with the data of their occurrence in New England.

1. Head with two long slender spines projecting forward; color brown, connexivum very distinctly banded, terminal antennal segment pale; length 11–14 mm. *armigera*
   Head without prominent spines projecting forward 2
2. Head with a small tubercle just behind the base of each antenna; color light to dark brown, with coarse black punctation, lateral margins of pronotum pale, connexivum indistinctly banded; terminal antennal segment dark; length 14–17 mm. . . . . *tristis*
   Head without such tubercles; color light yellowish-brown, lateral margins of pronotum concolorous, connexivum distinctly banded, terminal antennal segment pale orange yellow; length 12–15 mm. . . . . *repetita*

A. tristis De Geer. The squash-bug. Throughout New England; 11 May to 16 October.

A. repetita Heidemann. The cucumber-bug.
Massachusetts—Allston, Amherst, Beach Bluff, Boston, Northampton; 13 June to 24 September.
Connecticut—Wallingford.

A. armigera Say. The horned squash-bug.
Massachusetts—Amherst, Boston, Northampton; 4 June to 24 September.

NOTES FROM TASMANIA

By Frank M. Littler, *Launceston, Tasmania*

Currant Clearwing Moth. The currant clearwing moth (*Aegeria* [*Sesia*] *tipuliformis* Clerck) has been noticeably on the increase on red, white, and black currant bushes in various parts of Tasmania during the past few years. So far as is known it has not as yet appeared in the southern half of the island. The insect as a pest has been known to the writer for the past ten years. Neither raspberries, nor gooseberries yet appear to be affected. The perfect insect makes its appearance during November, and odd ones may be captured up to early January. By May the larvæ are nearly full grown, and from then until early spring they remain practically quiescent. The length

of the pupal stage has yet to be determined; it will doubtless be found to approximate that in other countries. The eggs appear to be always laid close to a bud or shoot. During last summer the writer was successful in discovering a parasite in the shape of an Ichneumon very close to the Tribe Rhyssides. The species is fairly plentiful so that there is a chance that it will keep the pest within bounds, especially as the former does not appear to suffer from any hyper-parasite.

As the result of a series of investigations and experiments regarding certain phases of the life of the clearwing moth's larvæ, it was ascertained that they can and do work both up and down, or vice versa, in the tunnels made in the branches. The point of entrance is likewise that of exit. The larvæ were found capable of crawling over themselves, so to speak, in their narrow tunnels when wishful of changing the direction of burrowing. Whether a larva first commenced feeding down or up was found to be a mere matter of chance. Evidences were discovered of grubs feeding downwards until they came to an obstruction, then having slightly enlarged the feeding cavity, turned round (end for end, in common parlance) and fed upwards beyond the point of entrance, until a similar obstruction in the shape of woody pith had been met with. The enlarging and turning movements were then repeated and the larvæ found headed downwards and near the point where the exit would take place.

No official action has been taken by the Tasmanian Agricultural Department against the pest, but there is a likelihood of such being the case, if a general pests act now under consideration comes into force. The writer has recommended through the Press, the destruction of all badly affected currant bushes, vigorous pruning of bushes during the winter in affected plantations and destruction by fire of the parts cut away, care in selecting cuttings for striking, and the spraying of the bushes, immediately after the fruit has been picked, with arsenate of lead. These suggestions have been carried out by a number of growers with satisfactory results.

Rutherglen Fruit-Bug. The summer of 1916–17 was remarkable for the quantity of rain that fell intermittently all through. As a natural sequence there was a superabundance of plant growth, noxious and otherwise. The result was that pests of several kinds were more plentiful than in normal years. This was markedly so with regard to the Hemipterous bug, *Nysius vinitor*. The insect is indigenous to this State, and although it has been known to the writer to be yearly increasing in abundance, yet no complaints had been made by farmers or horticulturists with reference to damage committed. The Launceston Marine Board had an area of reclaimed land, adjoining one of the parks, on which a most luxuriant growth of all manner of noxious

weeds had been allowed to flourish. Early in the year it was found that the immature insects in countless myriads were migrating from the reclamation area onto the park in one direction, and along the gutters of the public streets in another. After some little delay on the part of the Government, steps were taken to isolate the breeding ground. Coal tar was spread round the edges where it did not join the park, and also in the gutters where the insects had traveled. The migration of further immature forms to the park was more or less prevented by spraying. The weeds on the area were cut and burnt. Nevertheless the measures were not sufficient to prevent a very large number of both mature and immature forms escaping. Unless the present winter proves severe, the writer fears that next spring will see the pest very plentiful over a wide area. Only two instances came under his notice where the insects caused damage, one person had the plants in his flower garden destroyed, and another lost his tomatoes. He has seen in Victoria (Australia) gardens destroyed, save for hardy shrubs, and soft fruits utterly ruined by this pest. Not only in many places in Victoria was the insect exceptionally plentiful last summer, but also in New South Wales. Potato crops suffered in addition to soft fruits, and flowering plants. Benzole emulsion as a spray, and smudge fires under the fruit-trees were found the most effective means of combating the insects.

Codling Moth. In Tasmania the codling moth (*Carpocapsa pomonella*) is single brooded, but the hatchings are extended over a long period. In some districts the larvæ are at work long before those in another make an appearance. Some years ago and before poison sprays had reached the pitch of excellence they now have, the pest was greatly feared and justly so, for the annual amount of damage was very great. Paris green was then almost solely used in conjunction with bandaging. Although a codling moth act was in force empowering heavy penalties to be inflicted for non-removal of bandages, and destruction of larvæ therein, etc., yet great carelessness and neglect were shown by many orchardists. Arsenate of lead has almost, if not quite, completely taken the place of Paris green, this together with a more intelligent system of spraying has reduced the codling moth to almost harmless proportions, and made the act as it now stands nearly obsolete. There are, of course, individual orchards where wormy fruit abounds, but they are the exception. The exhibition of such fruit for sale or contemplated sale in auction marts, or shops invariably leads to it being seized, and heavy penalties inflicted on the responsible parties.

Nearly every season as spraying time approaches discussions take place in the daily and weekly press regarding whether the first spray

should be made before the closing of the calyx lobes or not. Both sides have their advocates who can produce figures from their own orchards to prove or disprove one theory or the other. For some years past the writer has been collecting data from his own personal examination of apples and pears from several orchards concerning where the young larvæ enter. The averages deducted from some thousands of fruit examined show that 46 per cent were struck through the eye, 35 per cent at the base of the stalk, while for 19 per cent the mode of entry was through the side. In every instance the individual fruit was cut open in order to avoid any confusion between the entrance hole and that of exit. To my mind the above figures prove that the first spraying should take place prior to the closing of the calyx lobes, but that it should be followed by a second and a third application in order to render the fruit immune from the later hatching larvae.

THE COMMON EARWIG (*Forficula auricularia*) although causing a good deal of damage in flower gardens, and a certain amount in kitchen gardens, is capable of performing very meritorious work in the way of destroying codling moth larvæ under bandages. I have seen every larva that had gone to change into the pupal stage in a badly infested orchard eaten out. Nevertheless orchardists do not feel justified, and rightly so, in allowing earwigs to flourish.

HARLEQUIN FRUIT-BUG. In common with other Hemipterous insects the soldier bug or Harlequin fruit-bug (*Dindymus versicolor*) was excessively plentiful during the summer of 1916–17. The principal damage done by this pest is causing the berries of red, white, and black currants to fall before they are ripe. The fruit is punctured just at the bases of the stalks. Some of the softer varieties of apples are also treated in the same manner, causing disfiguring blemishes. During the period under review they turned their attentions to sunflower, and artichoke stems, after all the soft fruits were picked. In many instances the stems were so severely punctured that from the ground to the flower heads they were almost completely covered with knobby excrescences. Neither the sunflower heads, nor the artichoke tubers were in any way affected. All melliferous flowers were continually covered with the insects in all stages of growth. Paling fences were favourite gathering places for the insects, clusters of many hundreds being a common sight. Boiling water was usually most effective in dealing with such swarms. Those on plants and flowers were dealt with by jarring into hot water, or water on which a film of oil had been spread. The swarming thousands of these brightly colored insects was a constant matter of comment, even by persons who usually are unobservant of insect life.

THE DEVELOPMENT OF A PORTABLE INSECTARY

By A. W. Young, *U. S. Bureau of Entomology, Melrose Highlands, Mass.*

In the spring of 1914 the entomologist in charge of the gipsy moth investigations for the Bureau of Entomology decided on a line of intimate field study in infested woodland at Lunenburg, Mass. As much of the experimental work was to be done under full control, some means of shelter was indispensable. An outer fly of a small tent was used the first season, but owing to the abnormal fluctuations in temperature and humidity under this, it was replaced the following year by a larger tent and fly, having its walls and ends covered with mosquito netting for the protection of the feeding trays, boxes and jars from outside interference. With slight modifications this tent served our purpose for three seasons, when it became necessary to renew many parts. The climatic data for previous years showed that we were carrying on delicate experimental work under conditions ten degrees above normal when the sun shone, so that the results were far from conclusive. It was determined to build an ideal shelter, as a result of four years practical experience. In order to fill our particular requirements this Insectary was built on the following principles: It must be strong, simple and portable, of sectional construction, made of non-conducting material with a continuous ventilating space from the eaves to ridge between the outer and inner walls.

This Insectary, 11 x 19 feet 7¾ inches, was set on 7 posts, had 1 front sill, 1 back sill, 2 door studs, 1 door head, 12 rafters, ridge pole, 6 rafter ties, 4 corner angle braces, 10 roof panels, 8 roof battens, saddle boards, 2 screens on each side set directly on the posts (without sills), 3 front screens and door and 2 back screens.

Materials used—in linear feet—158 ft. of 2 x 4 in. spruce, 126 ft. of 2 x 3 in. spruce, 164 ft. of ⅞ x 3 in. pine, 400 ft. of ⅞ x 2 in. pine, 20 ft. of ⅞ x 5 in. pine, 20 ft. of ⅞ x 6 in. pine, 41 ft. of ⅝ x 2½ in. pine batten, and 7 chestnut posts 3 ft. long and 6 in. in diameter. Bolts—26 2½-in., 10 3-in., 8 4-in., 33 6-in. Screws—14 2½-in., 50 ¾-in., one box of 1-in. brads, 8 lbs. of 2-in. wire nails with large heads, 90 ft. of 36-in. wire mosquito screening, 320 sq. ft. of heavy and 320 sq. ft. of medium weight wallboard; 4 gal. of white paint, 1 gal. of spar varnish, 2 spring hinges, and 1 door latch and lock. All lumber was planed on four sides for painting. All bolts were ¼-in. in diameter with two washers, one under the head and the other under the nut.

Seven chestnut posts were set, the tops of those at the corners were sawed 3½ in. square to allow for bolts each way, the two set at the center on the sides and the one under the door were sawed on one outer face only, all were cut 3½ in. deep or the thickness of the sills, which

rest on the shoulders so formed. Four sectional screen frames form the side walls, each built of 2 x 4 in. spruce, having two beams 9 ft. 9 in. long and three beams 3 ft. 5 in. long. The shorter beams are halved to the inner sides of each end and middle of the long beams and fastened together with $2\frac{1}{2}$-in. bolts, forming a rigid frame to be covered as are all the other frames, with 36-in. wire mosquito netting. This is adjusted as follows: saw clear $\frac{7}{8}$-in. pine boards of suitable length into 3/16-in. strips, plane and sandpaper on one side. Place one linear edge of the netting on the inner edge of the frame the long way, lapping on $\frac{3}{4}$ in. and fasten in place with a strip above mentioned, using a 1-in. brad every 3 in. to hold firmly, nail strip on the netting down the center beam; next nail strip opposite the first beginning at the center beam and nailing towards the ends to avoid pulling screening unevenly, pull netting taut by gripping outer edge with pinchers (as the width of netting required to cover with these measurements is 2 ft. 11 in. there will be a margin of 1 in. left outside the strip for pulling), nail the end strips last, being careful to allow 1 in. outside, this may be readily trimmed off with a sharp knife after nailing. The two end sills of 2 x 4 in. spruce are 11 ft. long, halved on to the lower projecting end of side screen, with $\frac{7}{8}$ in. exposed for a base on which to rest the end screens. All of these are fastened with 6-in. bolts to the posts which were set so that the bottom of sills and side screens rest on the surface of the ground; these should be treated with creosote.

The floor is of earth or gravel. Fit 12 2 x 3 in. spruce rafters 7 ft. 7 in. long, the upper end sawed at the proper angle to adjust against the face of ridge pole with a $2\frac{1}{2}$-in. screw, the end being exactly flush with the top. The lower end of the rafter should have a right angle notch cut so that one-third of the thickness of the rafter will bear against the vertical side of screen and two-thirds will rest on the top, to give greater thickness for holding a $2\frac{1}{2}$-in. screw inserted in the counter-sunk hole passing through the end of rafter into top of screen. In locations where extra strength is not required, because of mild climate, protected situation, or the short period during which the Insectary is set up in any one place, the rafters may be omitted entirely by using strips of 2 x 2 in. in place of the $\frac{7}{8}$ x 2 in. stock for the two joists forming the outer sides of each panel frame; the roof panel being held in place by a bolt at the ridge and one on each side inserted into the top of side screen.

The ridge should be beveled at the proper angle to make the surface of the panel fit closely. In case rafters are not used the interior ties for preventing the spread of the roof should be of 2 x 3 in. spruce and fastened to it by a bolt passing through an iron cleat 1 x 3 in. and $\frac{1}{4}$ in. thick (in place of upper washer), down between the abutting sides of

panels and diagonally through the end of the rafter tie, with a washer and nut on the inner side. Fit the ridge pole of two beams of 2 x 4 in. spruce 10 ft. long, to be halved together by a 6 in. splice fastened by two $2\frac{1}{2}$-in. bolts. Fit four corner angle braces of 2 x 3 in. spruce 3 ft. 5 in. long, halved on lower end for fastening to sill with 4-in. bolt, the upper end to be cut at the proper angle to fit against side screen and fastened by 4-in. bolt with its head on outer side of screen. Set the end rafters flush with the end of side screens and end of ridge pole; set the intervening eight rafters at such points that the abutting edges of two roof panels will meet on the center of each rafter. Fit the door frame on the center of front sill, of 2 x 3 in. spruce 6 ft. 7 in. long, the lower ends halved on to the inner face of sill; the upper ends halved into the door head of 2 x 3 in. spruce 3 ft. 10 in. long, the ends of door head cut at an angle to fit against the under surface of the rafters and fastened by $2\frac{1}{2}$-in. screws. Fit the rafter ties of $\frac{7}{8}$ x 3 in. spruce or pine, 4 ft. 9 in. long, with the ends cut at the angle of the top of the rafters. These are fastened by 3-in. bolts, at the same level as the door head forming the top of door frame, to the face of each of the remaining pairs of rafters. No supporting posts under the ridge are required as the whole roof is trussed.

The roof is covered by ten panels 4 x 8 ft., the frame of each is built of four strips of pine $\frac{7}{8}$ x 2 in. and 7 ft. $6\frac{1}{4}$ in. long, set up edgewise; to the ends nail a strip $\frac{7}{8}$ x 2 in. and 4 ft. long; the end pieces have nine $\frac{3}{4}$-in. holes to allow ventilation from eaves to ridge between an outer and inner single sheet (4 x 8 ft.) of wallboard nailed to each side of the frame. Heavy $\frac{1}{4}$-in. stock should be used for the outer surface while the next thinner grade will answer for the inside; this wallboard is fastened with 2-in. wire nails having broad, flat heads, driving one every six inches around the outer edge of frame and one every twelve inches into the two interior stringers. Eight strips of pine batten $\frac{5}{8}$ x $2\frac{1}{2}$ in. are required. Each one has a groove $\frac{1}{2}$ in. wide x $\frac{1}{4}$ in. deep, cut $\frac{1}{2}$ in. from the edge of strip, and is nailed to one edge of a panel on the upper side, its center being over the joint formed by two abutting panels. On the opposite upper side is fastened a bead $\frac{3}{8}$ in. wide and $\frac{1}{4}$ in. high, with 1-in. brads in such a place as to fit into the corresponding groove on the next panel for the purpose of preventing the rain from beating under the batten and down between the abutting panels.

The roof panels are fastened in place by two 6-in. bolts in each, one in the center of the top through the panel and diagonally through the ridge pole, and one through the side of frame and rafter, two feet from the bottom. These panels and building frame are covered with two coats of white paint with the addition of a coat of spar varnish on the outside of roof. The saddle boards are made up of $\frac{7}{8}$ x 5 and 6 in. pine,

nailed together at right angles, this is held in place by a screw into each panel; extra ventilation may be had by allowing the battens to extend under the saddle boards, raising the latter a little from the panels. The front and back screens and door are of $\frac{7}{8}$ x 3 in. pine, halved and fastened together at each union by two $\frac{3}{4}$-in. screws.

The door is 6 ft. $2\frac{1}{2}$ in. x 2 ft. $9\frac{1}{2}$ in. with one horizontal cross tie. The two front side screens are 6 ft. $2\frac{1}{2}$ in. on side next the door; 4 ft. $1\frac{1}{2}$ in. base; 3 ft. $1\frac{1}{2}$ in. on outside vertical edge; 4 ft. $4\frac{1}{2}$ in. on oblique edge, flush with the top of rafter, and $11\frac{1}{2}$ in. on top; each has one horizontal cross tie at the same height as the door. The triangular screen over the door is 4 ft. $8\frac{1}{2}$ in. at the base, and 3 ft. $3\frac{1}{4}$ in. on the oblique sides, which are also flush with the top of the rafter. The two back screens are 8 ft. 5 in. on their longest vertical, 3 ft. $1\frac{1}{2}$ in. on outside vertical, 5 ft. 6 in. on base, 7 ft. 8 in. on the top oblique edge flush with the top of rafter, the joint at the abutting edges under the ridge is covered by a $\frac{5}{8}$ x $2\frac{1}{2}$ in. batten.

The interior may be arranged to suit the needs of the investigation. We found that benches 30 in. wide and 28 in. from the bottom of the sill, along both sides and rear end, also a narrow hanging shelf 16 in. wide, set on a level with the top of side screen and supported by brackets fastened to each rafter, made a very convenient arrangement. The benches were of the heavier wallboard laid on a suitable frame.

The approximate cost of this Insectary was as follows: Wallboard, \$55; lumber and hardware, \$25; paint and varnish, \$20. A carpenter and one assistant should build this structure in six days.

We have found this Insectary thoroughly practical, solving our problem for maintaining normal climatic conditions under full control, which is a first requisite for the development of delicate experimental work.

The writer is very grateful to Mr. A. F. Burgess, entomologist in charge, for enthusiastic support and encouragement, and to many of the assistants of the Bureau at the Gipsy Moth Laboratory for helpful suggestions. Among these special credit is due Mr. H. A. Preston for preparing photographs, Mr. Irving T. Guild for drafting plans, and to Mr. J. V. Schaffner, Jr., and E. R. Sturges who assisted in planning and construction work.

A drawing showing the details of construction is reproduced as plate 17 and a blueprint can be furnished to anyone desiring to build an Insectary of this sort.

Scientific Notes

A Suggestion for Tagging Trees. A note by Mr. F. C. Craighead in the June letter of the Bureau of Entomology on the use of the ordinary linen frank tag for labeling trees, leads me to suggest another form of tag that is good for this purpose.

In marking fruit-trees in which wood-boring larvæ are working it is sometimes necessary to use labels that will remain legible for five years or more. For this purpose I have found nothing equal to zinc tags marked with a soft lead pencil. Sheet zinc is cut into tags of the size required, the tags perforated and attached to the trees with copper wire. It is easy to write on the zinc with a soft lead pencil and the writing lasts for a long while. I have tags of this kind that have been hanging on trees for fourteen years and the pencil markings on most of them are still distinct.

Fred E. Brooks.

Flies Associated with a Grasshopper Outbreak. Bombyllid flies were noticed in great abundance during the first two weeks of September, 1918, in parts of Lassen and Sierra Counties, California, where grasshoppers have been very plentiful for the last two years. A species of Anthrax, near Alpha, was especially noticeable in the vicinity of Loyalton and in these regions grasshoppers had not caused the injury that they had in other parts of Lassen County. In one alfalfa field the constant humming of the flies annoyed the horses so that cutting was considerably hindered, the flies evidently being mistaken for bees. In this same region a similar outbreak of Bombyllids, although a different species, was recorded by C. V. Riley in the "American Naturalist," June, 1881. At this time, it is stated, an outbreak of grasshoppers lasting three years was largely checked by the work of these flies in the larval stage on the grasshopper eggs.

E. Ralph de Ong.

Insect Pests of the Castor Bean. Castor beans, grown this year for the first time in quantities throughout the state of California, are being adopted as host plants by our common insects. Reports have come in from the northern part of the state of an unidentified cutworm attacking the young seedlings and in the south a species of Blapstinus caused serious damage by feeding on the stems of the young plants at the surface of the ground. This manner of attack by a species of Blapstinus is common in California on newly set tomatoes. In the overflow lands near Sacramento, the larva of *Laphygma flavimaculatus* (Harv.), commonly known as the beet army worm, attacked the leaves of plants in the blooming stage. The young caterpillars fed beneath a protecting web on the upper surface of the leaf, the attack usually beginning at the point of attachment to the stem. This was apparently the second brood of the year as moths bred from these caterpillars are ovipositing in September.

E. Ralph de Ong.

The Common Cricket, Gryllus assimilis, as a Cotton Seed Pest. Early in September the reporters were sent to a large plantation at Deeson in the Mississippi delta to investigate a serious outbreak of something, thought possibly to be the Pink Bollworm, damaging cotton seed in the newly opened bolls.

Nothing was found at work on the bolls during the day, but an investigation at night with the aid of electric flash-lights revealed the large black ground cricket, *Gryllus assimilis* Fab., variety *luctuosus* Serv., determined by Mr. Wm. T. Davis, in the act of combing away the lint from the upper seeds in the newly opened bolls, cutting away the seed hull and eating out the contents.

The particularly dry season in that section this summer and the consequent sparsity of vegetation usually fed upon by the crickets may have driven them to this new food material. Crickets are also reported to be unusually abundant there this year.

The upper seed in one or more of the carpels or bolls on the plants was eaten out. In cotton fallen on the ground, all seeds were damaged in this way. It was estimated that 10 per cent or more of the seed were thus destroyed. Small fragments of hulls which become embedded in the lint surrounding the seed, and which can not be ginned out, will cause a marked reduction in its grade.

The damaged bolls are very conspicuous. The hollow empty half hulls of the seeds show up dark against the lint. Particles of the seed content and hull spread about on and among the surrounding lint give it a charred appearance.

O. I. Snapp,
E. W. Stafford.

Sugar-Cane Borer (*Diatræa saccharalis*). Early stages. The larva and pupa of this species show the key characters of the Galleriinæ rather than Crambinæ in Fracker's and Miss Mosher's keys. (Fracker, S. B., Ill. Biol. Mon. II: 1, p. 87; Mosher, E. Bull. Ill. St. Lab. N. H. XII: 2, p. 72.) They may be distinguished from the Galleriinæ as follows: In the larva setæ iv and v (kappa and eta of Fracker) are almost vertically placed on their common tubercle, and the hooks on the inner side of the prolegs are also of three lengths. The pupa has the short tongue and rudimentary pilifer of the Galleriinæ, but is easily separated by the slender form, suited to a boring species that pupates in its burrow, and by the body sculpture, which is of sharp raised reticulations, rising here and there into pyramidal points. The larva may be distinguished from that of Chilo, which has similar habits, by the complete circle of hooks on the prolegs. The pupa of Chilo is unknown to me.

W. T. M. Forbes, *Ithaca, N. Y.*

Injury to Hogs Resulting from Cocoon Eating. The following article is an abstract of a paper published in the "Journal of the American Veterinary Medical Association," by Dr. F. M. Hayes, Veterinary Surgeon of the University of California. Permission was kindly granted by Dr. Hayes for publishing same in the Journal of Economic Entomology so as to give greater publicity to this matter.

In June, 1918, Dr. F. M. Hayes, Veterinary Surgeon of the University of California was called to investigate a disease of hogs which had been ranging in oak timber in one of the coast counties of California. He writes in part as follows: ". . . from the two ranches reporting trouble thirty hogs out of eighty-two had died and the remainder of the herds were showing symptoms of disorder.

"The most prominent symptom noted was defaection of long strings of feces. This was accompanied by severe straining which resulted in many cases in leaving a trail of several inches of feces still attached to the hog. An autopsy performed upon a pig showing symptoms of abdominal distress revealed an undigested mass continuous from the stomach to the anus. A dissection of this material showed it to be largely composed of a fine, wool-like fiber enmeshing bits of grass, barley hulls, and small fragments of a dark brown material. . . .

"On examining the range, the cocoons of tent caterpillars were found in great abundance scattered about on low plants and on oak leaves. Some of the oaks were practically defoliated, many caterpillars still being in evidence. The owner stated that this was the severest outbreak of caterpillars he had seen in ten years' residence there.

"On examination of the cocoon, the fiber was found to be identical with that found in the intestines, the dark brown fragments in the mass mentioned above proved to be masticated pupæ. Cocoons when thrown to the hogs were consumed readily, especially by the younger animals showing that they had acquired a decided appetite for this type of food.

"No treatment was advised other than to keep the hogs away from the infested

range until the moths had emerged. The majority of the affected animals recovered under this treatment. The older hogs either had not acquired a liking for the juicy pupæ or were better able to take care of the indigestable silk fibre of the cocoon."

The above article reveals an interesting result from an outbreak of *Malacosoma disstria* (Hub.), examples of which are not uncommon. Tent caterpillars have been unusually abundant in the coast counties this year but the above record is the only one reported of injury to grazing stock.

E. Ralph de Ong.

Gracillaria zachrysa Meyr., attacks Apple Foliage in Northwestern India. The following letter has been received from Mr. T. Bainbrigge Fletcher, Imperial Entomologist, Agricultural Research Institute, Pusa, Bihar, India, dated July 31, 1918:

Dear Doctor Howard:

"In the Proceedings of our Second Entomological Meeting (p. 248) I have referred to a Gracillariad caterpillar attacking apple leaves in Northwestern India. We were able to obtain moths later on and I have now received its identification by Mr. Meyrick as *Gracillaria zachrysa* Meyr. As I note that this insect has lately been imported into the states on Azaleas from Japan via Holland, I think it is as well to let you know this at once in case it should become acclimatized and turn its attention to apples with you also.

"The same or a very similar species (specimens have only emerged today and I cannot compare them critically until they are off the setting boards) is also common on apple at Shillong, in Assam (N. E. India) so that it seems possible that this insect occurs in all the apple growing districts along the Himalayan region and, as these localities have mostly a very hard winter, there is the less reason why *G. zachrysa* should find difficulty in acclimatizing itself in the states. At present I gather (Entom. News, XXIX, 114) that it is chiefly a greenhouse pest."

Under date of August 2, 1918, Mr. Fletcher adds:

"In continuation of my letter of July 31, I have now examined the adult of apple Gracillariad from Shillong (Assam) and make it to be *G. zachrysa*, as supposed, the Assam species agreeing exactly with others from N. W. India named by Meyrick."

Mr. Fletcher's communications will be of decided interest to American entomologists in view of the establishment of this insect in the United States.

L. O. Howard.

Caribou Warble Grubs Edible. There is an interesting reference in the October 1918 *Ottawa Naturalist* by R. M. Anderson to the edibility of caribou warble grubs. He states that the Eskimos pick out the grubs from the hides in the spring and eat them like cherries and adds, apparently from experience, that they are very watery and absolutely tasteless. This is not so very different from the report of some months ago upon the "white grub sandwich," only fewer "trimmings" appear to be necessary.

E. P. Felt.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1918

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The readjustments of peace are facing the country. The urgent need for increased production must continue for some time and in this, as during the last two seasons, the practical entomologist must continue to play an important part. The same need for a close watch upon insect development in the field with the special purpose of anticipating and preventing serious injury must continue. The call for discrimination between the serious pest and the comparatively trivial is hardly less urgent, and here, as well as in many other fields, the applied entomologist will find much that can not be done by others. It is real service to the country. It is one of the best opportunities to demonstrate the practical value of economic entomology.

The war has stimulated investigations into the bionomics of various camp pests. There have been great additions to our knowledge of these pernicious forms and methods have been developed which will prove of great service in controlling insects under field conditions. Many of these investigations have not been completed and it is important that they be brought to a successful conclusion as far as possible, since knowledge of this character is not only of great value in time of conflict but it is essential to the successful handling of problems where sanitary ideals are still primitive. We need every advantage bestowed by a knowledge of disease carrying insects if we would live up to our opportunities.

The end of the war shifts the emphasis to be placed upon insects and their part in carrying disease, though it is none the less important. The battlefield and camp problems are less urgent. Conditions in the

war stricken areas are favorable to the spread of disease. Various infections have been widely distributed as a result of the wholesale movement and dissemination of troops and with entire nations suffering from malnutrition, conditions will be almost ideal for extensive epidemics when warm weather permits insects to become, once more, active carriers of disease. The control of the situation is rendered more difficult by the great reduction in man power. This makes it almost impossible to approximate the none too sanitary prewar conditions in a number of European countries. The seriousness of the situation is shown by the developments following earlier conflicts. Dr. Prinzing in his "Epidemics Resulting from Wars" has brought together evidence showing that "the most serious human cost of war has been not losses in the field, nor even the losses from disease in the armies, but the losses from epidemics disseminated among the civil populations." He points out that it was "the war epidemics and their sequelæ, rather than military losses, that accounted for the deep prostration of Germany after the Thirty Years' War. Such epidemics were also the gravest consequence of the Napoleonic Wars." Shall we allow these results to follow this world war? Recent investigations show that the control of insect borne diseases is not wholly a medical problem. The checking of the carriers is entomological work. The European situation offers unexampled opportunities for economic entomologists and sanitarians to coöperate effectively in saving these well nigh helpless peoples from the logical outcome of this fearful struggle. It is conservation of human lives and man power at the very time when such is most urgently needed in the rehabilitation of nations.

OBITUARY

FREDERICK KNAB

November 2, 1918. Word has just come that Mr. Frederick Knab, entomological assistant in the Bureau of Entomology, and, since the death of Mr. Coquillett, honorary custodian of the Diptera in the National Museum, has died. Mr. Knab first entered the Bureau in April, 1906, and during his twelve years' work with us gained a very high rank. His scientific work was of the highest character; his reading was broad, and was facilitated by his knowledge of several foreign languages. He had traveled extensively in his earlier years, and, in fact, while in Brazil some time before he came to the Bureau he probably contracted the obscure disease that eventually ended his life. He was not incapacitated for work, however, until comparatively recently, and during the whole period in which the disease remained

dormant and slowly progressed, his researches on disease-bearing insects, and especially on mosquitoes, made him one of the foremost workers in this field. He was an artist of very unusual ability, as is especially shown by the wonderful illustrations of mosquito larvæ reproduced in the Carnegie Institution Monograph of the Mosquitoes of North and Central America and the West Indies and which, in fact, reached the summit of beauty and perfection. His training in art was received as a young man in Dresden. L. O. H.

EVERETT JAY VOSLER

EVERETT J. VOSLER, foreign collector for the Insectary Division of the California State Commission of Horticulture, died on November 7th, at Fort Rosecrans, San Diego, Cal., of pneumonia following influenza.

Mr. Vosler was born on July 13, 1890, at Fort Collins, Colo. After attending high school there he entered the Colorado Agricultural College from which he was graduated in 1911. He specialized in horticulture and entomology and made an enviable record as a student, although he carried on a great deal of outside work while pursuing his studies. He was also prominent in athletics, winning the college championship in tennis and being a member of the baseball team.

In 1911, after finishing his college course, he entered the service of the United States Department of Agriculture as an expert in the Bureau of Entomology, section of cereal and forage insect investigations. He was assigned to work on the alfalfa weevil problem at Salt Lake City, Utah. Here he remained until the spring of 1913 when he accepted a position as assistant superintendent of the California State Insectary. In September, 1914, he was promoted to the secretaryship of the Commission which included the editorship of the *Monthly Bulletin*. In January, 1917, he was, on account of his success in handling living insects, made foreign collector of the Insectary Division and sent to Australia to collect beneficial insects. He brought back to this country a number of promising species of parasites and predators, particularly on mealybugs and black scale.

Upon his return he made every exertion to get his work in such shape that he could enlist in the army, waiving all claims to exemption, which was offered him. He joined the 25th Artillery at Fort Rosecrans, only a few days after which he was stricken with the malady from which he never recorered.

Mr. Vosler was well informed in horticulture as well as entomology, and was an unusually successful grower of chrysanthemums. While he was not a voluminous writer, his great energy and thoroughness enabled him to accomplish a great deal of work on the life-histories of

insects, the results of which are contained in his notes filed at the State Insectary. He was very fond of out-door sports and played, as he worked, with all the energy at his command.

His death is not only a loss to the profession but is a deep personal one to his many friends and we all are better men for having associated with him.

HARRY S. SMITH.

Review

The Insect and Related Pests of Egypt. Vol. I, The Insect and Related Pests Injurious to the Cotton Plant. Part I, The Pink Bollworm, by F. C. WILLCOCKS. Sultanic Agric. Soc., quarto, 339 pages, 17 text figures and 10 plates, 4 colored, 1916.

This work deals with a very exhaustive investigation of the insect pest which is now attracting very great attention in most of the cotton producing countries of the world, and which threatens to become established in the United States. It is a most welcome publication on account of its timeliness and on account of the painstaking work upon which it is evidently based. It is most fortunate for the cotton producers of the world that it has been possible under the difficulties of the present time to publish the work in such full and commendable form.

The work covers all phases of the pink boll-worm problem in Egypt, including the history and origin of the infestation, the nature and amount of the losses, food plants, life history (in the broadest sense), natural enemies and means of control.

The thoroughness of the work is indicated by the number of individual observations on points in the life history of the pest. In most cases scores or hundreds of observations were made on such points as the duration of the stages. The form and amount of damage under various conditions is indicated by equally numerous observations.

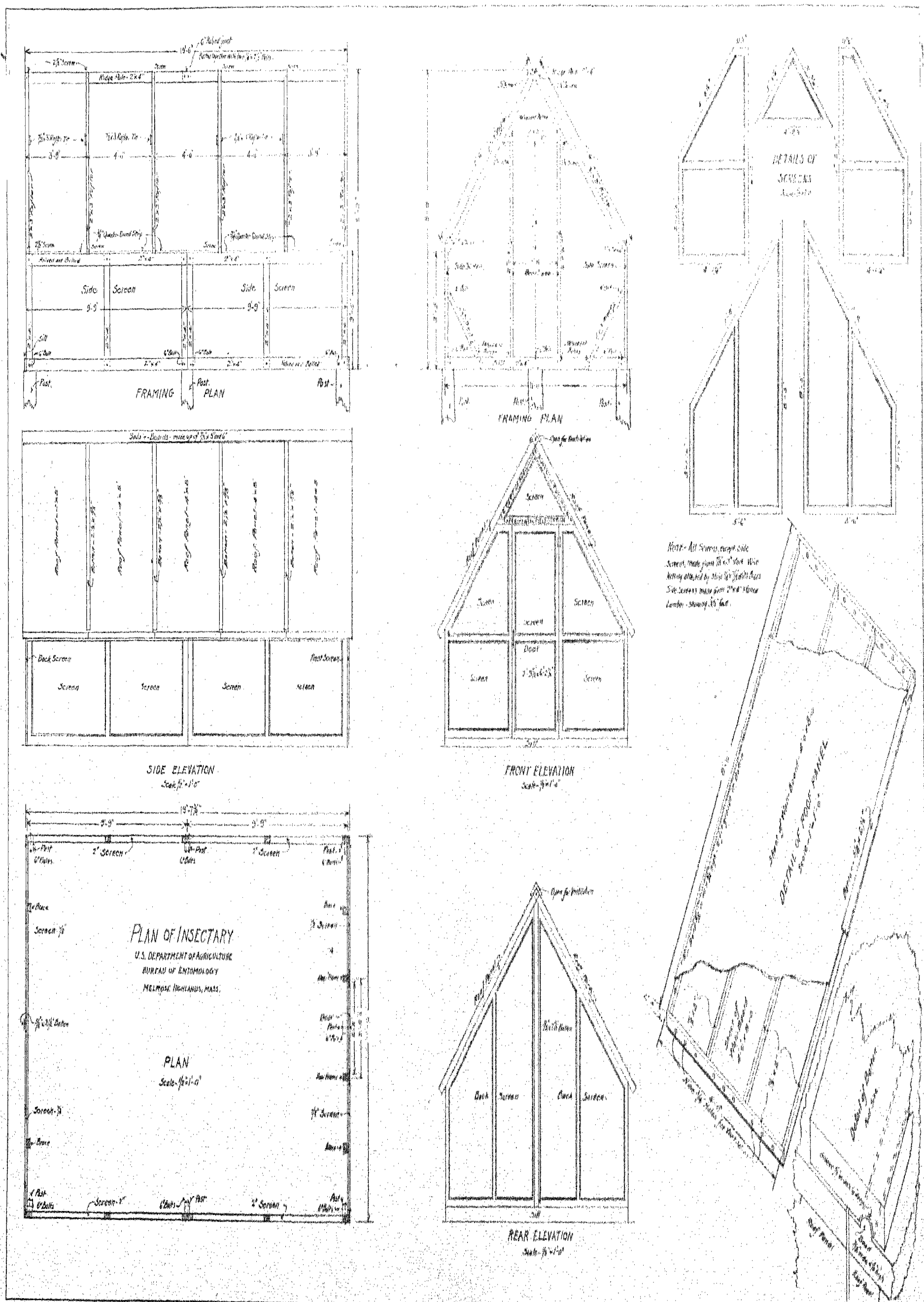
The author shows that the pink bollworm was introduced in Egypt about 1906, at which time there was a very great increase in the amount of Indian cotton imported into that country. There was a very high proportion of seed left in the Indian consignments. The view is held that India is undoubtedly the original home of the pest.

American entomologists will be especially interested in the author's remarks regarding the possibility of the adaptation of the pink bollworm to the conditions existing in the United States. The following are his remarks on this subject:

"If the pink bollworm once gained a footing in the Southern States it would stand a good chance of becoming firmly established and might well prove to be as serious a pest to cotton as the notorious Mexican cottonboll weevil.

"The climate being suitable for commercial cotton growing, there seems no particular reason or reasons to doubt that it would not also be favorable to *Gelechia gossypiella*. It is true that frosts occur in some parts of the cotton growing belt; but nothing approaching sufficient severity to seriously inconvenience this species would be experienced, since this insect appears to be particularly resistant or adaptable to both heat and cold."

A very careful analysis of the statistics of production of cotton in Egypt, together with records of studies in individual fields, leads the author to the conclusion that in 1914 there was a loss of approximately one hundred pounds of seed cotton per acre. This is said to represent from 21 to 27 per cent of the crop.



Plan of Field Insectary (Reduced from 27.5 to 11.25 in.)

Several new points connected with the life history of the insect are brought out. Among these is the spinning of a web by the first stage larva in many cases, under which it works while boring its way through the carpel of the boll. The statement is also made that the pink bollworm has been observed to injure the stem of cotton plants. At one of the experimental farms a number of plants had broken off about six inches above the ground. Examinations showed that at the break the stem had been completely girdled, and the culprit was found to be the pink bollworm. The feeding of the larva in the blooms, which has been referred to only casually by other writers, is dealt with fully. In many cases the larva works in the pollen where it spins a protecting membrane and pupates. This habit has recently been observed in Mexico, but the Mexican observations have not been published. Of equal interest are the exact data regarding the location of the eggs on the cotton plant. In an examination of twenty-five plants a total of fifty-nine eggs were found. Of these 62 per cent were on small leaves at growing points and about the squares, 12 per cent on large leaves, 10 per cent on squares, 12 per cent on bolls and 3 per cent on the bracts of squares and bolls.

The author found that moths would emerge after a resting larval stage of twenty months. Only 28 per cent of the larvae were killed by sixty-nine hours submergence in water.

Control measures are treated exhaustively, but they are largely peculiar to Egyptian conditions and will not be dealt with here.

The author has made one of the most important contributions to entomological science which has been presented for several years. He is to be congratulated on the work he has done, and it is to be hoped that the appearance of the remaining portion of the volume and of other possible volumes may not be long delayed.

W. D. Hunter,
Bureau of Entomology.

Current Notes

Mr. Henry L. Viereck of the Bureau of Biological Survey, was married, October 24, to Ida Adele Pearce Davis of Washington, D. C.

Mr. Walter W. Marshall, formerly instructor in zoölogy, University of Minnesota, died October 4, at Camp Sherman, Ohio, while attached to the Base Hospital.

Mr. Frank C. Pellett, for five years state apiarist of Iowa, has recently become associate editor of the American Bee Journal, and his address is now Hamilton, Ill.

Major General William C. Gorgas has been made a grand officer of the Order of the Crown of Italy, in recognition of his distinguished services is behalf of military sanitation.

The degree of doctor of laws has been conferred on Dr. Arthur E. Shipley by the University of Michigan. Dr. Shipley is a member of the British Educational Mission to the United States.

Transfers in the Bureau of Entomology have been made recently as follows: Oscar Barber, Texas, to the Office of Markets; Carl Heinrich, Forest Entomology, temporarily to the Federal Horticultural Board for the study of the pink bollworm.

Prof. E. Dwight Sanderson, formerly entomologist at the Delaware, Texas and New Hampshire stations and director of the New Hampshire and West Virginia stations, who has been engaged in special work in the Office of Extension Work, North and

West, U. S. Department of Agriculture, since last February, has been elected professor of Rural Organization in the New York State College of Agriculture at Cornell University.

Dr. Arthur Everett Shipley, the well-known zoölogist and vice-chancellor of the University of Cambridge is now in the United States as head of a commission to secure closer coöperation between American and British educational institutions.

Dr. A. C. Chandler, assistant in zoölogy, and F. H. Lathrop, research assistant in entomology, Oregon Agricultural College, have received commissions as second lieutenants in the Sanitary Corps, and have been granted leave of absence from their college work for the duration of the war.

Dr. E. D. Ball, state entomologist of Wisconsin, took up his work as chairman of the Department of Zoölogy and Entomology at the Iowa State College, Ames, on October 20. He will also be chief of the Entomological Department of the Experiment Station and state entomologist.

Prof. C. L. Metcalf, assistant professor of economic entomology at the Ohio State University, Columbus, Ohio, has been granted a leave of absence for the entire year and is engaged in graduate study at the Bussey Institution of Harvard University, Forest Hills, Mass. He is specializing in the dipterous family Syrphidæ.

According to Science Professor Maxwell-LeFroy, professor of entomology at the Imperial College of Science, London, has accepted a year's engagement with the Commonwealth Government for £3,000, plus £2,000 for experiments. He will investigate the blowfly, the grain weevil, the woolly aphis, prickly pear and St. Johnswort.

Mr. V. E. A. Daecke, assistant in the Bureau of Zoölogy, Department of Agriculture, Harrisburg, Pa., died at Richmond, Long Island, N. Y., October 27. Mr. Daecke was a specialist in the Diptera, and a member of the Entomological Society of America, the Academy of Natural Sciences of Philadelphia, and a fellow of the Harrisburg Natural History Society.

Harold Morrison, Bureau of Entomology, has left for tropical insect work, and plans to cover such of the Islands of the Lesser Antilles as are of sufficient commercial or agricultural importance to justify an entomological survey. The field will extend from the Virgin Islands south to Trinidad and may also include British Guiana and other portions of the northern coast of South America.

Experimental work with the Smith machine at Philadelphia by the Bureau of Entomology has demonstrated that bean weevils, rice weevils, and the Angoumois grain moth can be killed by passing the infested seed through an electrical field. It remains to be seen whether the inventor can make good his belief that he can kill insects in grains and other seeds passed through a machine at the rate of 200 to 300 tons per hour. While this machine has yet to be perfected, it promises much.

The following appointments are announced by the Bureau of Entomology: Mr. Arthur E. Mallory, Kansas State University, scientific assistant, truck crop insects, Greeley, Colo.; Miss Anna R. Frank, Los Angeles, Calif., scientific assistant, Southern field crop insects, for duty at Washington, D. C.; Lloyd P. O'Dowd, field assistant, sugar-cane insect laboratory, New Orleans, La.; L. R. Watson, extension work in bee culture, Storrs, Conn.; H. A. Scullen, apicultural extension work in Washington, Oregon, Montana and Northern Idaho; H. L. McMurray, apicultural

extension work in Wisconsin and Minnesota; W. A. Smith, apicultural extension work in Georgia.

A conference on the Oriental Peach Moth, *Laspeyresia molesta* was held at the Bureau of Entomology, Washington, D. C., November 12, at 10 o'clock a. m. The distribution, life history, injury, danger of spread and quarantine possibilities were discussed. The danger of spread by means of shipped fruit was considered far greater than by means of nursery stock, and any quarantine should include both. It was thought best not to establish any Federal quarantine at present. The following were present: Messrs. C. L. Marlatt, A. L. Quaintance, E. R. Sasscer, W. B. Wood, Bureau of Entomology; R. C. Althouse, Federal Horticultural Board; T. B. Symons, E. N. Cory, Philip Garman, Maryland; J. G. Sanders, Mr. Hoopes, Pennsylvania; T. J. Headlee, New Jersey; Wesley Webb, Delaware; Geo. G. Atwood, New York; W. E. Britton, Connecticut; W. E. Rumsey, West Virginia; L. A. Stearns, Mr. Underhill, Virginia.

The following resignations are reported from the Bureau of Entomology: Miss Edith M. Brace, scientific assistant, Southern field crop insects, to return to teaching in New York City for the winter; J. P. Landry, truck crop insects, Louisiana, to enter the army; J. W. Sauer, truck crop insects, Kingsville, Texas, to resume his educational work; Victor Duran, truck crop insects, Alhambra, Calif., to enter the army; G. J. Hucker, cereal and forage insects, Nebraska, to enter military service in the Sanitary Corps; J. M. Langston, cereal and forage insects, Forest Grove, Ore., to engage in state work in Mississippi; Miss Mabel Stehle, scientific assistant, truck crop insects, to accept an appointment as instructor in zoölogy at Clemson College, S. C.; deciduous fruit insect investigations as follows: W. D. Whitcomb, J. H. Boyd, H. E. Spaulding, J. N. Lowe, D. R. Royder, to enter the army; M. B. Boyd, A. E. Booth, to enter private business; H. B. Pierson, E. W. Babcock, Geo. H. Vansell, to reënter college; Frazier Rogers to accept a position as assistant professor of agronomy, University of Florida; K. E. Bragdon to resume his work with the Florida State Plant Board; C. H. Arndt to accept a fellowship in medicine; H. L. Weatherby to resume educational work in Savannah, Ga.; Max M. Reeher, cereal and forage insects, Forest Grove, Ore., has been granted an indefinite furlough to enter military service; H. M. Fort of the same division has entered the Medical Corps.

Mailed December 17, 1918.

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